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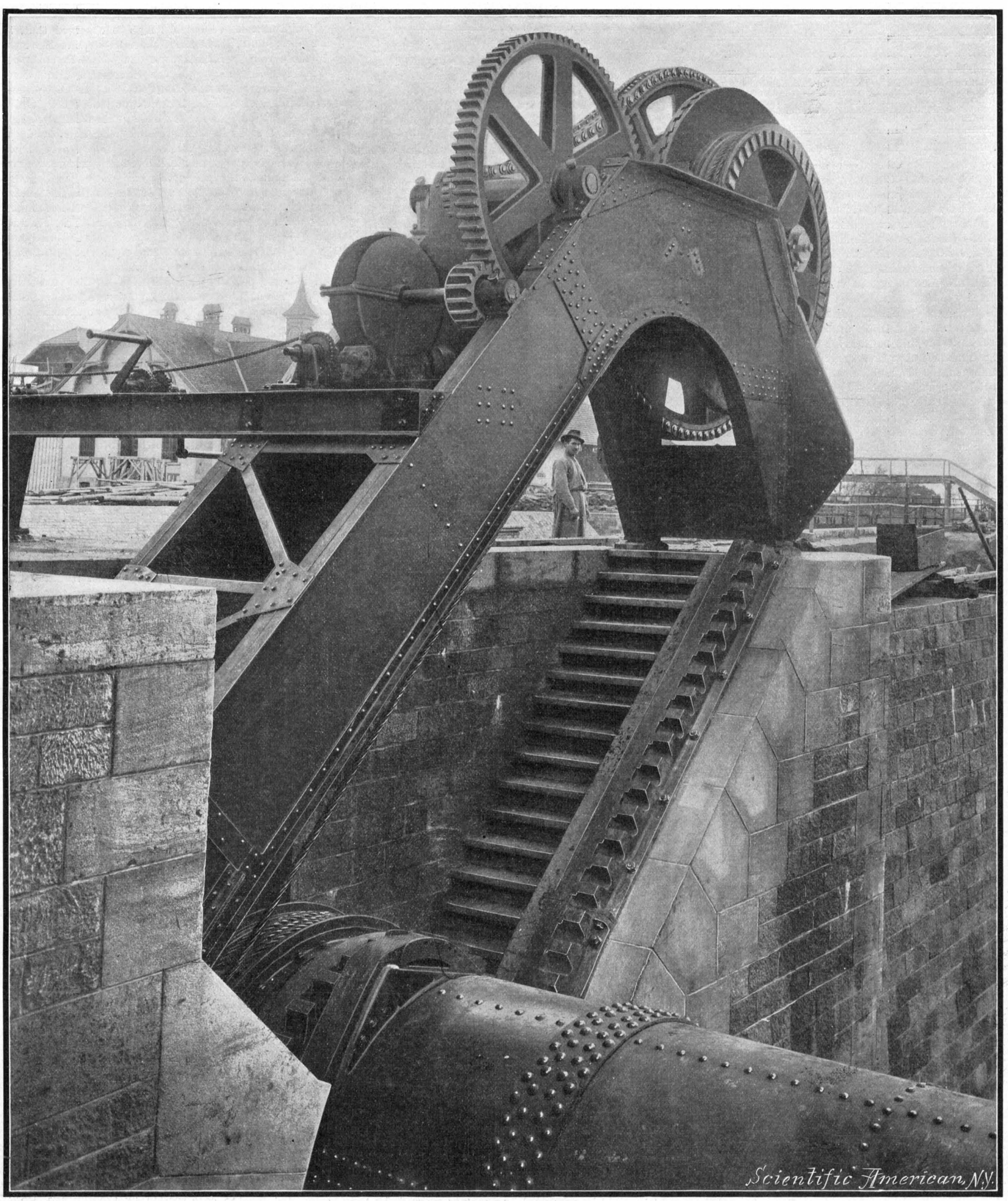

THE HOISTING MECHANISM OF THE GREAT ROLLER DAM AT SCHWEINFURT, GERMANY, SHOWING THE RACK IN THE MASONRY ABUTMENT, UPON WHICH THE CYLINDER MOVES.—[See page 312.]

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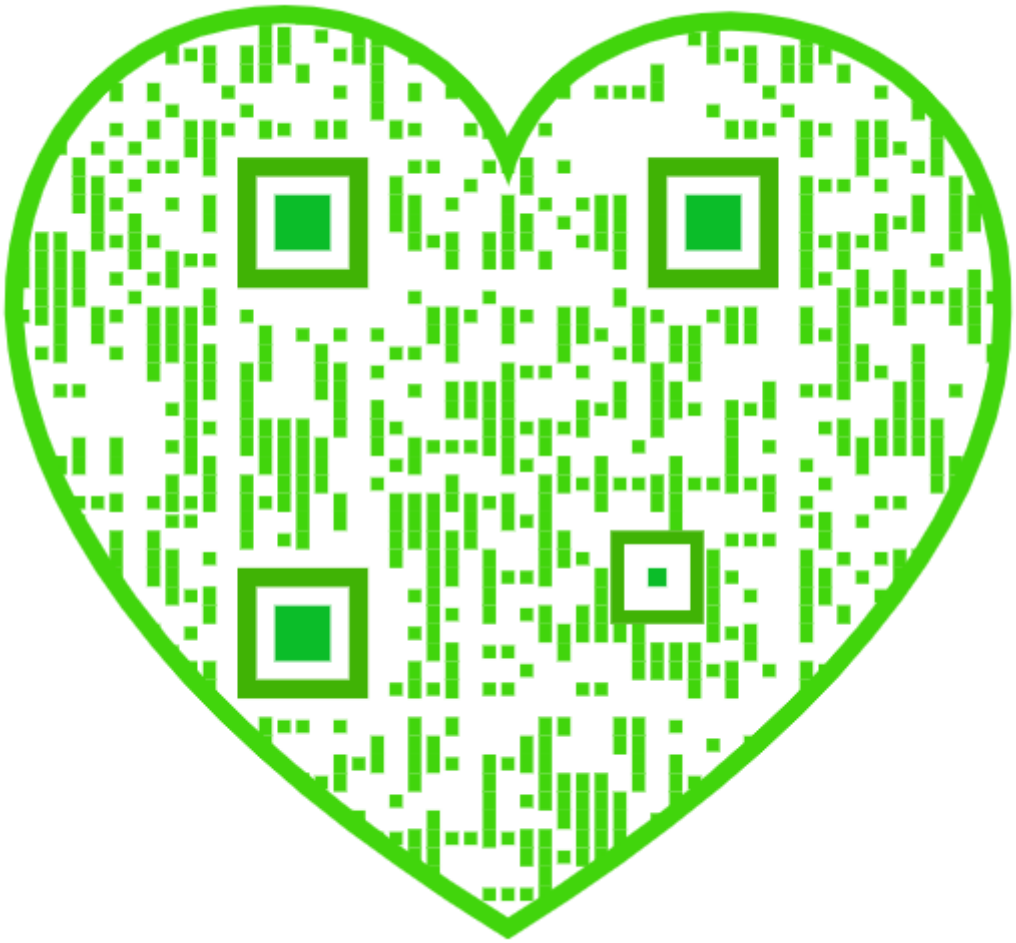

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NEW YORK, SATURDAY, APRIL 16, 1904.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

TURBINE ENGINES FOR THE NEW CUNARDERS.

Great interest attaches to the announcement that the Cunard Steamship Company, guided by the expert commission which was appointed to investigate the subject, have decided to install turbine engines on the two large passenger steamers which they are about to build with the assistance of the British government. The readers of the SCIENTIFIC AMERICAN were prepared for this announcement by the article which we published a few months ago in which, by the courtesy of the local representative of the company, we were enabled to give the leading dimensions of these great ships, and state that in all probability the decision of the committee would be in favor of the turbine.

The announcement is a most momentous one, and by many engineers and steamship men it is considered that the company has shown great daring in applying the turbine to engines which will probably indicate when pushed to their maximum capacity, about 75,000 horse-power. It is argued that the success of the turbine on small river and cross-channel steamers of not over 1,500 to 2,000 tons displacement does not guarantee its success when applied to vessels of such an unprecedented size as these new Cunarders. The SCIENTIFIC AMERICAN has never shared any of these doubts. Indeed, we have always urged that there were no complications, no novel conditions, to limit the usefulness of the turbine if it should be installed in the engine room of a large modern steamship; that, on the contrary, the duty required of the engines of fast Atlantic liners is of the very kind in which the steam turbine has shown to best advantage, namely, when it is running continuously, at high speed, and under full load.

The committee which was appointed last September was probably one of the strongest and most representative that could have been gathered together. It included, among others, the superintendent engineer of the Cunard Company, the late director of naval construction, and the deputy engineer-in-chief of the British navy, and the engineering managers of three of the largest shipbuilding companies in Great Britain, including a member of Messrs. Denny & Co., who have built most of the turbine-propelled passenger ships that are now in service. When the committee was formed, there was only a small amount of information available as to the relative economy of turbine and reciprocating engines when they were doing similar work and developing the same amount of power. The work of the committee was directed to making careful comparative tests under such conditions. One of these was carried on at Newcastle-on-Tyne, where reciprocating and turbine engines were run at various proportions of their power and also at full speed, the output of electricity being recorded in each case and the condensed steam from the engines being accurately measured. In addition to these tests ashore, others were carried out on the sister passenger steamships "Arundel" and "Brighton," which are identical in everything but motive power, the "Brighton" being driven by turbine engines and the "Arundel" by reciprocating engines. The two vessels were run side by side from New Haven to Dieppe and back, all possibilities of error due to variations of weather and tide being thus eliminated. Subsequently the "Brighton" made several trials in the Solent, running at different rates of speed.

Throughout the whole investigation the committee have been fully alive to the fact that it was a great step from the successful propulsion of ships of the size of the "Arundel" by turbines to the fitting of this type of engine in vessels of the great dimensions of the new Cunard ships. Consequently great attention has been paid to the design of the tubines, with a view to rendering their manufacture as simple as possible, and to securing the well-known advantages in efficiency due to increased size.

The dimensions of the ships, as already announced, are: Length on deck 800 feet, beam 85 feet, minimum draft between 33 and 34 feet, on which dimensions the vessels will have a displacement of about 40,000 tons. These figures may be compared with those of the "Kaiser Wilhelm II.," which is the largest of the high-speed transatlantic liners. This vessel on a length of 706 feet has a beam of 72 feet and a draft of 29 feet, the draft being limited by the depth of the water in the German ports. The contract will probably require that the new Cunarders develop a speed of 25 knots on trial and a sustained sea speed of 24½ knots an hour.

The 75,000 horse-power will be developed upon four shafts. On the outer pair will be the high-pressure turbines; on the inner pair the low-pressure, and also the go-astern turbines. The coal consumption will be over 1,000 tons a day.

THE GROWTH OF OUR STREET RAILWAY SYSTEMS.

Our readers are familiar with the annual statistics of the steam railroads of the United States which we publish regularly in the SCIENTIFIC AMERICAN. Hitherto we have not been in the habit of giving similar statistics of the street railways; but the latter have grown in mileage, passenger traffic and capitalization to such great proportions that for the future we hope to give the annual statistics of street railway and traction lines as well as the great steam railroads. For the figures that follow, we are indebted to Poor's Manual for 1904, from which we learn that the total mileage of city, suburban and interurban track in the United States is 24,561 miles. Of this, 281.4 miles are operated by horse cars, 142.2 miles by dummy engines, 267.8 miles by the cable, while 23,869.6 miles are operated electrically. For the operation of the horse-car lines 7,923 horses and mules are employed; for the dummy lines there are 475 dummies and locomotives; for the electric lines 52,119 motor cars are required; while for all lines there are needed for operation 13,301 passenger and freight cars. The immense value of these properties may be judged from the fact that the capital stock amounts to the sum of $1,685,840,296; while the bonded debt is $1,180,313,809. The electrically operated roads have increased from 10,239 miles in 1894 to 23,869.6 in 1903. At the same time the lines operated by dummies and locomotives have decreased from 409 to 142.2; those operated by cable from 578 to 267.8, and those operated by horses from 1,950 to 281.4 miles. While the total mileage has not quite doubled in this period, the capital stock has increased over 150 per cent, while the bonded indebtedness has increased by even a larger ratio.

A BARRAGE ON THE RIVER THAMES.

For some time past considerable dissatisfaction has existed in those shipping circles whose traffic is concerned with the Port of London, because of the insufficient depth of water in the river. Owing to the increasing size and tonnage of steamships, it is often necessary to await a favorable tide at Gravesend, which delays are detrimental to the commercial interests of the port of London. Then again the navigation channel up the river is so narrow and so crowded that traffic is seriously impeded. Many plans have been advocated for the surmounting of these obstacles. One of the most ambitious of these is to emulate the engineering achievements on the River Nile in the Aswan and Asyut barrages, by the construction of a great dam across the river between Tilbury and Gravesend, and convert the forty-six miles of the river between Teddington Lock and Gravesend into one huge basin or dock.

The projectors of this scheme, of which complete plans and specifications have been prepared, contend that as the river level can be regulated by the erection of such a barrage as this, it will be possible to obtain a navigable depth of water varying from 65 feet at Gravesend to 32 feet at London Bridge, without dredging, together with a fairway to allow ships drawing 30 feet of water to proceed to London Bridge at any time, irrespective of the tide.

The barrage would be constructed on the same lines as those at Aswan and Asyut on the River Nile. It would be built of mass concrete, faced with granite on all exposed faces. The foundations of the barrage would be in the underlying chalk, and they would be built by means of large coffer dams, inclosing an area sufficient for the walls and locks. The latter, when completed, would be opened for the up and down traffic of the river while the construction of the wiers and sluices was proceeded with. The sluices would be left open for the free passage of the tides until the closing of the barrage, which would take place at high water of a spring tide. The locks would be worked electrically from a power house built upon the central pier of the locks, the necessary electric energy for which would be generated by dynamos operated by the fall of part of the water flowing over the dam. The river traffic would be signaled and regulated from a pilot house, from which also the locks, movable bridges, etc., would be controlled. Four locks are proposed, each provided with internal gates in addition to the outer ones, in order that they may be worked in long or short lengths to suit the traffic. The lengths provided in this way would be 300 feet, 500 feet, 700 feet, and 1,000 feet, and the widths 80 feet and 100 feet. It is not likely that these dimensions will ever be exceeded by steamships. There would be a roadway across the barrage, for pedestrian and vehicular traffic.

A tunnel 28 feet wide by 25 feet in height is also proposed in the base of the barrage to afford a means of communication between the trunk railroads on either side of the river. The cost of this project is estimated at $18,290,000, and it is proposed to meet this expenditure by levying a toll of 1½ cents per ton upon all vessels passing up and down the river.

ACTION OF LIGHT UPON THE FORMATION OF ACCUMULATORS.

Dr. Tommasi, of Paris, long ago observed that, in an accumulator, a negative plate exposed to the light is more rapidly formed than one placed in darkness. This reducing action of the light always manifests itself whatever be the composition of the active material contained in the accumulator plates, the density of the sulphuric acid that serves as an electrolyte, and the temperature at which the operation is effected.

In order to more perfectly establish the part played by luminous energy in the formation, or, more exactly, in the reduction of the active material of the negative plates to spongy lead, Dr. Tommasi made the following experiments: Two of his own type of accumulators, each composed of a glass vessel filled with acidulated water and containing three negative and two positive plates, were placed, one of them, *A*, in a place submitted to the action of the solar rays, and the other in a bitumen-coated cardboard box entirely closed on every side so as to completely protect the accumulator, *B*, from the action of the light. The two accumulators, *A* and *B*, were connected in series and submitted to a charge of from two to three amperes.

For thirty hours there was no perceptible difference; but, starting from this period, the negatives exposed to the light soon assumed a grayer tint—a certain proof of a greater advance in the formation. Such difference of tint, due to the reduction of a greater or less amount of oxide of lead, in the first place continues to increase, and then diminishes and finally disappears when the negatives are almost completely formed, i. e., reduced to spongy lead.

These experiments, several times repeated, show that the negatives of an accumulator are, all else being equal, formed more rapidly in light than in darkness.

This fact, as ascertained, is because of intent to find out how much influence was exerted by the light upon the speed of formation of the positive plates of accumulators. For this purpose, Dr. Tommasi mounted two of his own accumulators, each containing three positives, and two negatives, in such a way that the two end plates consisted of positives. One of the accumulators was exposed to the light and the other was kept in darkness. These accumulators, connected in series, were submitted to a rate of charging of from two to three amperes.

After twenty hours, the positives placed in darkness assumed a darker color, that is to say, were more peroxidized than were the positives exposed to the light.

Such difference in color increased at the outset, then diminished, and finally became inappreciable when the positives of the accumulators, *A'* and *B'*, were almost entirely formed, i. e., converted into peroxide of lead.

The positives of an accumulator, all things being equal, are therefore formed more rapidly in darkness than in light.

Besides, the positives formed in darkness have a dark brown hue, while those formed in the light are of a reddish brown. Such difference in color persists even after some few charges. In the long run, it at last disappears completely. The reddish color of the positives formed in the light becomes darker and darker until it finally assumes the brown hue of those formed in darkness.

Dr. Tommasi has likewise observed that negatives formed in the light have a lighter tint than those formed in darkness. Such difference is, however, not very marked.

As for the capacity, that remains sensibly the same whether the accumulators be formed in darkness or in light. We should be tempted to explain the phenomenon by an analogous one noted some time ago in connection with wireless telegraphy, viz., the charge that a condenser takes under the influence of solar light. Such charge would seem to oppose the formation of the positive plate and add its action to that which forms the negative one. This is a hypothesis of our own, which we submit with all reserve.

According to reports, arrangements are practically completed for the construction by the Chicago, Rock Island & Pacific Railroad of a line across Iowa between Davenport and Council Bluffs. The distance will be shortened considerably.

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LIGHT IN CRYSTALS.

BY A. C. MAURY.

Rays from a sacred ruby are fabled in the Rabbinical legends to have lighted the ark of Noah. The idea of a crystal as a fountain of light has been in all times congenial to the poetic imagination, and nature is less averse to poetry than is sometimes supposed. Many crystals shine in the dark, and some very pretty experiments showing this, may easily be made.

Many diamonds are thus luminous—a property which may enhance in our eyes the value of these precious stones. If rubbed with a woolen cloth or against a hard body, they appear surrounded with light. In particular, the pretty experiment is recommended of rubbing a diamond upon gold, when it shines "like a burning coal excited by the bellows."

Friction, while frequently aiding luminescence, is not its true cause. The essential condition of shining is previous exposure to light. The gem has been lying in the sun's rays, and these it has imprisoned, and now sets free in the dark. The sunbeams of Laputa were stored up in cucumbers; the real sunbeams are more fittingly stowed away in diamonds, and the crystal prison, as though because the light it holds is of no mere earthly fire, goes on shining even under water, like the fairy palace under the sea.

In warm water, indeed, the light becomes brighter, or may be made visible when not otherwise so. We read that in the thirteenth century the alchemist Albertus Magnus saw a diamond which shone when it was put into warm water, and this indicates the early discovery of an important law. In all cases where bodies shine after exposure to the sun, heat hastens the emission of light. It does not increase the total amount of light emitted, for though the body shines more brightly in proportion to the rise of temperature, yet the light lasts a proportionately shorter time. Borrowing a metaphor from coarse material things to describe this truly ethereal phenomenon, it has been said that the phosphorescent body soaks up light like a sponge, and heat squeezes it out.

The effect of friction on phosphorescent diamonds has been proved to be independent of electricity, and may be a modified form of the heat effect. Some facts, however, would seem to render this doubtful, as when Dana, speaking in his "Mineralogy" of the phosphorescence of sulphuret of zinc or blend, says, "Merely the rapid motion of a feather across some specimens will often elicit light more or less intense from this mineral." The effect of friction in disentangling the imprisoned light may therefore appear to be still mysterious.

The property of phosphorescence in diamonds is very capricious. Dr. J. W. Draper, in his Memoir on Phosphorescence, relates that a lady who was a relative had a pair of earrings in which were set two large and beautiful diamonds, both of which he found to be phosphorescent. They shone after exposure to the electric spark, which here took the place of sunlight. She had another pair, and the diamonds in both of these phosphoresced also. Yet in the necklace belonging to this set, containing thirty-eight fine stones, only one was phosphorescent. These were white diamonds. A yellow color would seem more favorable; thus Du Fay found that of four hundred yellow diamonds, all were phosphorescent, while some that were white, rose-colored, blue, or green were not.

We cannot always experiment freely on diamonds, but we may obtain equally beautiful effects with fluorspar crystals, especially those of the variety called chlorophane. A crystal of chlorophane, dropped into water nearly boiling, spreads around it a soft light like that of a glow-worm in the grass on a summer night, delicately tinged with olive green and illuminating beautifully the transparent form of the crystal. Or the fluorspar may, after dark, be placed on the kitchen stove. It soon becomes visible by its pale glow, then brightens till it seems filled to overflowing with the soft green-white light. The reader cannot be advised to try these experiments on his fine cabinet specimens, for, if they be more than slightly heated, they will be cracked and discolored. Ten or twenty cents' worth of broken crystals may be bought of a dealer in minerals, and the following very pretty experiment made:

The pieces are ground in a mortar till some are powdered, others remaining of various sizes. They are then sprinkled on a sheet of iron that has been heated somewhat below red heat in the colorless flame of a Bunsen burner—the experiment being of course done in a perfectly dark room. The fragments begin at once to shine, growing rapidly brighter. They pass through a fine series of color changes, the order of colors varying in different specimens. We may have greenish-white or orange changing to light blue, then rose color, then violet, which, passing through shades of deepening blue, finally becomes dark. The fine powder changes more rapidly than the coarser bits, so that the sheet appears strewn with rainbow colors. Some green fluor used by the writer gave a beautiful effect, the crystal dust turning quickly to an exquisite rose color, while the unbroken rectangular crystals shone like elfin lanterns, casting around a fine illumination, olive-green, orange, or blue.

Colorless or very clear fluor crystals ordinarily shine feebly or not at all; besides the green, the violet and blue generally shine well. Draper had a pale flesh-colored crystal of chlorophane, which excelled all his other specimens in the splendor of its light. It shone of a superb emerald-green color after receiving the rays of the sun. The warmth of the hand in a dark place made it shine. There is no fixed relation between the color of the crystal and the emitted light. At the moment when, after heating, the crystal becomes dark, its color is permanently discharged. There is also decrepitation, on which account it may be well to screen the operator's eyes.

If, in performing the above experiment, the reader grinds the crystals in the dark, he will see that eddies of light follow in the tracks of the pestle. Breaking, scratching, or cleaving a crystal is another mode of eliciting the light it holds thus "veiled in pure transparency." Fluorspar is phosphorescent both on heating and by cleavage; other crystals may be phosphorescent on cleavage, which on heating shine little or not at all.

While cracking up oyster-shells on a block of white marble of the variety called dolomite, the writer was one evening surprised by a flame-colored glow appearing where the dolomite was struck by the hammer. This spot in the white stone shone like a kindled coal, creating the curious impression that the stone was becoming red-hot under the hammer. It was, however, not hot to the touch. The effect was at first supposed to be due to the oyster-shells, which are well known to yield, on calcining, the phosphorescent calcium chloride. It was, however, found that the dolomite, which came from a neighboring quarry at Hastings-on-Hudson, was phosphorescent independently of the oyster-shells. It is well known that some dolomites have this property. A piece of the stone, rubbed with another, or scratched with a sharp instrument, shows in the dark flashes or streaks of fine orange light. Harder pressure or a smart blow of the hammer gives a flame-red glow. The orange streak is nearly instantaneous, but the reddish glow remains a moment before dying out. Pieces of ordinary hard and fine-grained marble do not phosphoresce, and among dolomites the softer varieties with large crystals give the best results.

More lively in its manifestations than this dolomite is a kind of stone found in northern New York and called significantly "hell-fire rock." Any one scratching with a sharp instrument a piece of this sulphurous-looking stone will see, in the dark, the true Mephistophelean fire. The streak is yellow, resembling that of sulphur matches.

The most beautiful exhibition of this kind was made by rubbing together briskly two fine pieces of rose quartz. The crystals, each the size of one's fist, were completely illuminated by brilliant flashes, which shed a light around, rendering the operator's hand visible. The flashes were instantaneous, resembling the illumination from electric sparks. The color of the light was generally white or light yellow, but sometimes the crystals sparkled orange color when their angles struck together and chipped. The experiment was of course most conveniently made by rubbing together broken surfaces of the crystals, so as not to impair handsome specimens. Smoked quartz and other varieties gave sparks as well as the rose.

In making the above experiments, an accident illustrated how it so often happens in the history of science that the investigation of one thing brings another to view. In the dark a finger was inadvertently thrust through a hole in the broken mica chimney of a drop-light, whereupon the bent edges of mica emitted a faint flash of light. The edges of the sheet must be struck obliquely, for it is the cleaving of the thin laminæ of the mica crystals which causes emission of light. It is interesting to note that the separated laminæ possess charges of opposite electricities, although from other evidence we suppose the phenomena of light and electricity independent.

Phosphorescence on cleavage is a property of a number of other crystals. The interesting case of loaf-sugar has been described in a former number of the Scientific American. The most beautiful example of all is said to be the phosphorescence of nitrate of uranium crystals. Each crystal broken in the dark is all lighted up, and provided they are thoroughly dry, it is only necessary to shake up a bowl or bottle of the crystals to cause a splendid display. This is of especial interest, on account of the connection of this substance with the discovery of radium.

Seeing that the shattering of the crystalline bonds causes emission of light, one naturally inquires whether crystals ever give out light in forming. We find that some crystals do, a most beautiful illustration being found in the crystallization of arsenious acid, the common "white arsenic" of commerce. As this experiment requires some laboratory apparatus and as success in it involves careful attention to certain details, it is reserved for a future article. A solution of the substance, properly prepared and set to cool slowly in the dark, sparkles as each tiny crystal forms, while the effect on shaking the solution resembles a fine display of the phosphorescent light at sea.

It is said that molten silver phosphoresces at the moment of solidification, and that water, when made to freeze with great rapidity, emits a flash of light clearly visible in the daytime.

SCIENCE NOTES.

In the report of the Marine Hospital Service of Vera Cruz on yellow fever the announcement is made that the parasite causing yellow fever has at last been discovered. The remarkable work recently done in Cuba by the late Major Reed and his colleagues convicted the mosquito of the spread of yellow fever, and disproved the ancient theory regarding the danger of the so-called formites—clothes, bedding, etc., with which yellow fever patients have been in contact. It was shown that contact with these was quite incapable of causing an attack of yellow fever, but that *Stegomyia fasciata*, a species of mosquito, was almost certainly the sole agent in spreading the disease. This important work was done, despite the fact that the actual cause of yellow fever, the germ, itself was not known. Several previous investigators, including Surgeon-General Sternberg, thought they had found it, but subsequent study disproved this. According to the Vera Cruz commission their microbe is a form of protozoan, similar to the malarial parasite, and not an ordinary bacterium. It goes through a cycle of changes analogous to those of the malarial germ, and its presence in the mosquito modifies the latter's life in a way to favor its spread of the disease.

In a note recently read before the German Physical Society, E. Goldstein presents the results of his experiments on the Giesel emanation body. This body, recently derived from pitchblende, seems to be related to cerium as to its chemical character; it shows emanation phenomena to a very high degree. On account of the small penetration power of this emanation, the author presumed that air would itself exert a strong absorption of the latter, so that its effects would be augmented in exhausted tubes. This hypothesis is borne out by the experiments recorded in the present communication. As regards the question whether the observed luminescence is due either to a gas or simply to a special form of energy issuing from the substance, the experiments of the author seem to be in favor of the latter hypothesis. When cooling exhausted tubes where the active matter had been introduced by means of liquid air, the author observed a very strong luminescence of the wall. This luminescence, so far from arising in the coldest portions of the wall immersed in liquid air, seems to be confined to a zone immediately above the level of the liquid air. This phenomenon is thus characteristic of a definite temperature above the temperature of liquid air. The author next states that the emanation is given off even at the temperature of liquid air; he does not think the emanation energy in question to be identical with that of radium, the mean distinguishing feature being the absence of a coloration of the tubes, and, second, the excessively low penetration.

Last spring Capt. Dana Porter, an American scientist, together with a party, left Mexico for the purpose of studying the Seri Indians on the Tiburon Island. The party has not been heard from, and the State Department at Washington has been unable to learn its fate. From information obtained by a party of Mexican soldiers, sent to the island in search of the scientist and his men, by request of Ambassador Clayton, it seems that the only signs of civilization on the island are some firearms, boats, and a pack of American playing-cards. The first, it is believed, were acquired by the Indians on their trips to the coast of Sonora, or probably belonged to persons who were on the island at the time of the disappearance of the Americans; for the firearms were very old. The boats may have belonged to the Americans. The pack of playing-cards was so new that it may be doubted whether it could have belonged to any member of the last expedition. Ordinary civilized persons could not live on the food of the inhabitants. The food consists of raw turtle, without any condiments, and venison in the same condition. The condition of the native residents of Tiburon Island is absolutely savage, and in appearance, dress, and features they resemble the aborigines of a country of the most remote type. The Tiburon Island is in the Gulf of California. It is thirty miles long and from twelve to twenty miles wide. It is inhabited entirely by the Seri Indians. The island is arid and rugged. Two centuries ago the population of the tribe was estimated at several thousand, but it has been greatly reduced by almost constant warfare to barely 350, of whom not more than seventy-five are adult males or warriors. The Seri men and women are of splendid physique. They have fine chests, with slender but sinewy limbs. They wear long hair, which is tawny in color. The strongest tribal characteristic of the Seri is an implacable animosity toward aliens, whether Indian or Caucasian.

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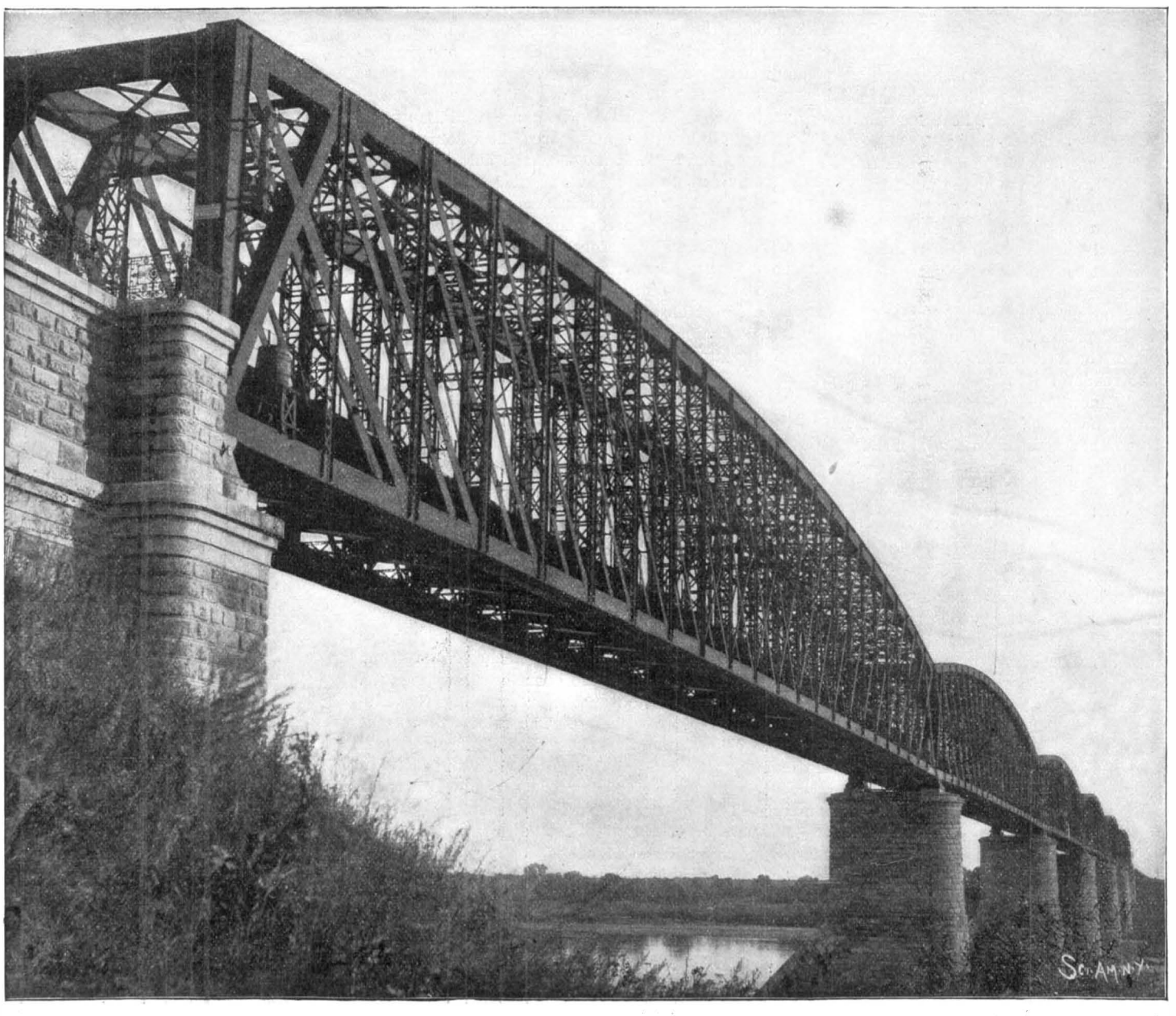
MILITARY ASPECTS OF THE TRANS-SIBERIAN RAILWAY.

Although the Trans-Siberian Railroad is just now the most valuable asset of the Russian government in prosecuting its war with Japan, this vast system was not originally planned for military purposes—not, at least, if we are to believe the original proclamation or "rescript" of the Emperor Alexander in which the construction of the road was authorized. It is given herewith, and the reader may judge for himself. This rescript is dated the 14th of May, 1891, and was received by the Grand Duke Czarevitch on his landing in that year from an important tour of inspection of the Far Eastern countries. "Having given the order to build a continuous line of railway across Siberia, which is to unite the rich Siberian provinces with the railway system of the interior, I intrust to you to declare my will upon your entering the Russian dominions, after your inspection of the foreign countries of the Far East. At the same time I wish you to lay the first stone at Vladivostock for the construction of the Ussuri line forming part of the Siberian Railway. . . Your participation in the achievement of this work will be a testimony of my ardent desire to facilitate communications between Siberia and the other countries of the empire, and to manifest my extreme anxiety to secure the peaceful prosperity of this country."—Alexander.

Thus was inaugurated a railroad which, in point of continuous distance covered, is altogether without a parallel even among the large railroads of the United States. It had been under advisement and more or less an object of solicitude on the part of the Russian government for a third of a century past. Actual construction was commenced on the 19th of May, 1891, when the Grand Duke Czarevitch filled a barrow with soil and emptied it on the railroad embankment.

The longest continuous line on the North American continent is the Canadian Pacific Railway, whose main line from Montreal to Victoria has a total length of 2,990 miles. The line of the Siberian Railway from Cheliabinsk to Vladivostock measures 4,776 miles. The branch from Harbin to Port Arthur measures 1,273 miles, so that the main line system, independently of its feeders, covers over 6,000 miles of track. From Vladivostock to St. Petersburg is about 6,700 miles, and from Port Arthur to the various harbors of the North Sea is about 6,900 miles by the nearest route.



THE TRANS-SIBERIAN RAILWAY—STEEL BRIDGE AT OUFA, OVER THE BIELAIA RIVER.

The road may be divided into six sections. The first or western section extends from Cheliabinsk, which is on the European frontier, to Pochitanka, a distance of 1,080 miles. It runs for about 900 miles over a highland plateau that is practically level. For over 600 miles it traverses an excellent agricultural country, while 300 miles west of Tomsk the line is laid through a good stock-raising district. The central division extends from Tomsk to Irkutsk, through upland country, whose climate and soil are both unsuitable for agricultural settlements. The third section includes Lake Baikal, and in this section the road reaches its utmost elevation, from which it drops to the Pacific slope, running through country rich in minerals, from which some $15,000,000 worth of gold is annually exported. The fourth section is that of the Amur, which extends toward the Pacific for a distance of 1,600 miles. This is the district which gives the greatest promise of future agricultural development. It is richly timbered and contains large sections of alluvial land and is favored with a more temperate climate. Then follows the Ussuri section, which extends to Vladivostock, on the Pacific, running through a hilly country suitable for agriculture and stock-raising, and containing an excellent bituminous coal. The branch through Manchuria from Harbin to Port Arthur is laid through a thickly-settled farming country. Although much of the country traveled by the Siberian road is inhospitable and barren, a competent authority has estimated that the valuable territory tributary to this great system that will be suitable for agriculture, is equal to the combined area of Germany, Austria, Belgium, the Netherlands, and Denmark, an area that, when once populated, will be fully capable of sustaining the railway out of local traffic alone. The only stretch of country which must be regarded, from the standpoint of railroad operation, as altogether unpromising is the 1,500 miles extending from Tomsk to the head waters of the Amur.

It is as a military road, however, that the great Siberian enterprise is just now vested with its chief interest. There is a popular belief, which seems to have grown by the relating thereof, that the road has been hastily and wretchedly built, and that under the severe strain of the war, it will be subject to continual breakdown, and probably fail to perform the military duties for which it was supposed to have been built. This impression we do not at all share, and the accompanying illustrations, most of which were furnished by Mr. Lodian, of this city, formerly for several years a resident of Siberia, show at a glance to any railroad man that in many respects the road is built in accordance with modern ideas and with structures that are well up to the very latest railroad practice. In the first place, the construction of the Siberian Railroad has been under the care of Prince Khilkoff, who was for several years a resident of the United States, and acquired a thoroughly practical knowledge of the construction and operation of American railroads. Consequently, it is fair to assume that the Siberian road has been built on carefully-considered and well-ordered plans, and that if there has been economy it has been of a judicious kind and exercised under the restraining hand of Prince Khilkoff, who is thoroughly familiar with roads of the same type in the United States, that have been built under the same restrictions of economy as this Siberian enterprise.

As a matter of fact, the road corresponds very closely to a pioneer American transcontinental system. It is single-track, and built for the comparatively light loads and engines which characterize a new railroad through an undeveloped country. In some respects it is considerably better built than were our own early Western railroads, as witness the invariable use of stone piers and abutments, masonry culverts, and steel superstructures.

The weakest point in the construction of the line is, or rather was, the very light rail that was used. The first 600 miles from Cheliabinsk was laid with rail that weighed but 54 pounds to the yard. This was found to be too light for the trains, and a heavier section, more suited to modern rolling stock, was adopted and has been laid over a majority of the road. The gage is the standard 5-foot gage of all Russian roads. The road is hampered by want of sufficient sidings at the stations. On the stretch of road from the European frontier to Lake Baikal, the track is laid over country that permits of long tangents. Thus for a continuous stretch of 880 miles in the western section, from Cheliabinsk to Pochitanka, the road is so straight that its total distance exceeds an air line by merely 2½ per cent, and in this division there are three stretches of absolutely straight line, one of which is 50, another 62, and another 86 miles in length.

The most troublesome portion of the line is the section that includes Lake Baikal, which lies in an exceedingly mountainous and rough country. For the present, freight and passengers are disembarked at the western end of Lake Baikal and ferried across to the terminus of the railroad at the eastern end. When the location of the line was made, it was found that the work of constructing the road around the lake would be of such magnitude and would consume so much time that it would be impossible to await its completion. In about eighteen months' or two years' time from now it is expected that this circum-Baikal route, as it is called, will be finished. The country is extremely difficult, and we are assured by one who has been over the route and is very familiar with it, that it is even more difficult of construction than the heaviest stretches of work on our own Colorado Midland road. This location is laid through a country which is so mountainous and precipitous that it is called by the Russians themselves the Switzerland of Siberia.

The impression that the Siberian road is poorly built and is liable to break down under the stress of military service is based upon the early condition of the line, before the heavier steel was laid and time had been given for ballasting and bringing up to standard such portions of the lines as were hastily laid in the endeavor to get the line pushed through to completion. We understand that an enormous amount of filling in and ballasting has been accomplished during the past year, and to-day the road is equal to taking care of trains and locomotives of the kind that have been supplied to the line. One advantage which this line has over some of our pioneer Western roads, is that the Russians have made very free use of embankments, preferring these to the more-hastily-built and less permanent pile trestles, which form such a conspicuous feature of our own Western roads. The earth or rock embankment, once made, requires very little subsequent care, and consequently the great amount of time

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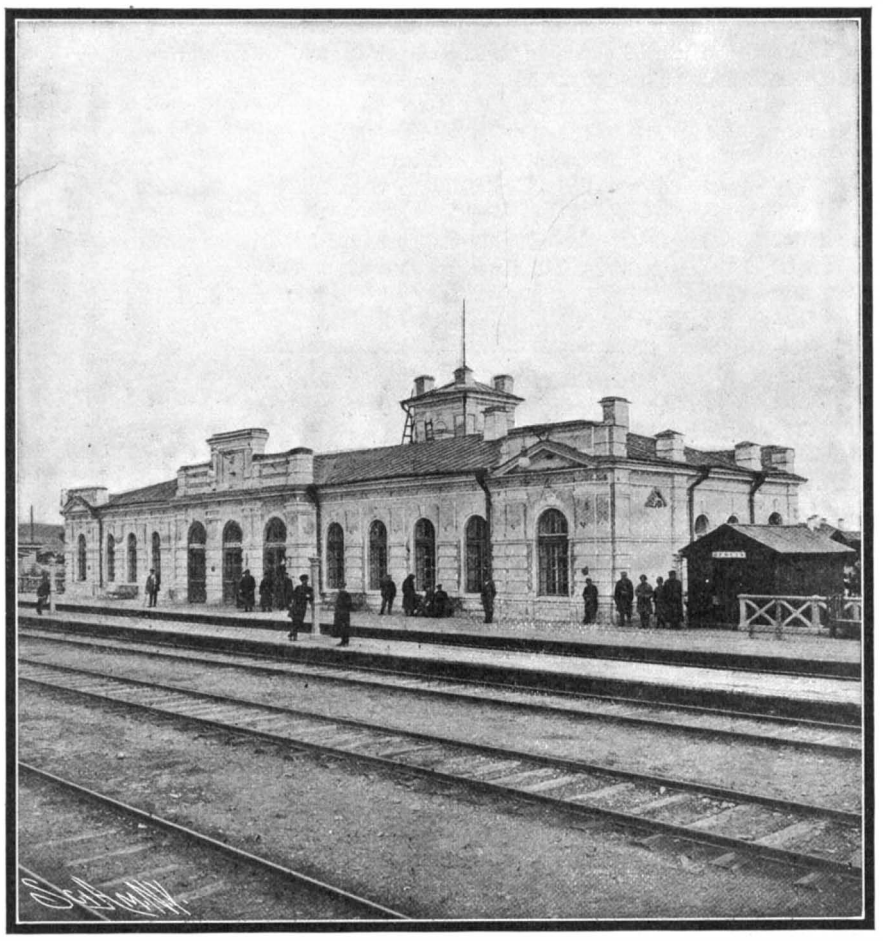
spent in maintaining ordinary trestle construction will be saved on the trans-Siberian road. The same is true of the culverts and piers which, as we have said, are practically all of good masonry.

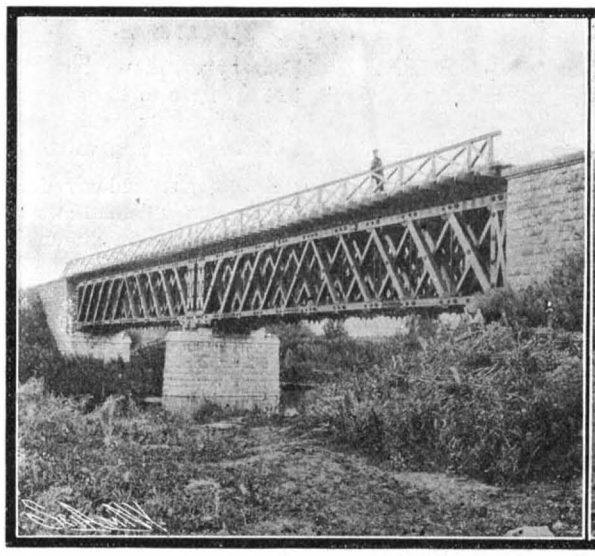
We think, however, that it would have been a wiser policy if the engineers had adopted a better class of track tie. As will be seen from our engraving, many of the ties consist merely of soft-wood trees cut to length and split in two. These are laid with the flat face down and a notch is adzed in each to receive the rails. The weak features of this type of tie are that it presents but small bearing surface for the base of the rail, which quickly cuts down into the tie, and also it is liable to rot out quicker than the square tie that is hewed on opposite faces. In one of our illustrations, showing the laying of the track, the latter form of tie is used, in another the half-round split tie, and the difference in stability and in bearing surface will be readily appreciated by comparing these two pictures.

Probably it will be found, as the war proceeds, that one of the elements of weakness in the line, for operation purposes, is that the sidings are not of sufficient length. These, however, can readily be lengthened so as to accommodate several trains at a time, and with ample provision of this kind, the road should be able to land at the seat of war a minimum of 800 troops a day with their supplies of food, ammunition, etc., and it might be able by excellent management and good luck in the matter of breakdowns to place as many as 1,200 troops a day at the front. We are informed by an eyewitness, who has just arrived from Lake Baikal, that 1,000 troops a day were being transported during the latter part of February, and it is likely that the lengthening of the sidings that is now going on, coupled with the experience that is being gained, will enable Russia to place troops at the front during the summer months at the rate of from 30,000 to 40,000 a month.

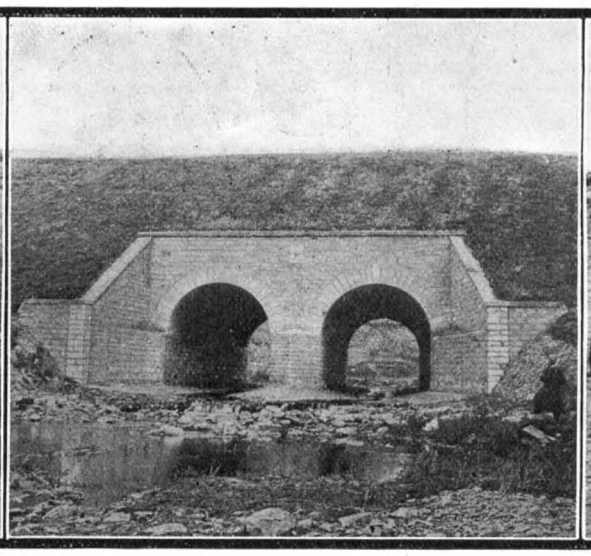


The Depot at Kraknoiarck, Central Siberia—A Most Important Mobilizing and Forwarding Station at the Present Juncture. Showing Substantial Character of the Buildings.

An instance of where brute strength triumphs with the modern wire-drawer as a wage-earning factor, as compared with the skill of the old-time wire-drawer, who had to make his own dies as well as draw his wire, is shown in the case of the champion of the Worcester works of the American Steel and Wire Company, who, according to the Iron Age, draws 10,000 pounds of three-draft wire a day. This man is a Finlander of enormous strength and endurance. To draw 10,000 pounds of wire means a lift of 40,000 pounds a day, 200 pounds at a time. The wire is drawn from No. 5 to No. 12½. He must lift the rod on the reel, then lift the coil off the block on the reel, for the second draft; repeat this operation, and finally lift the coil off the block on a barrow.

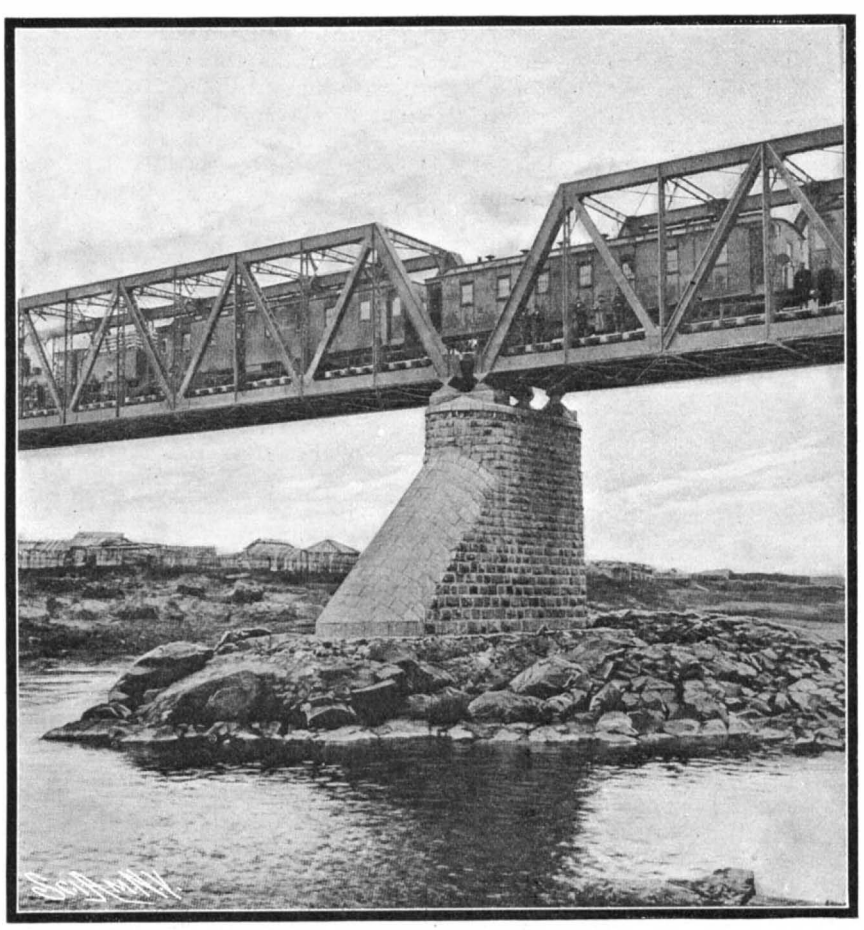


Howe Truss Bridge on the Central Siberian Section.



Type of Masonry Culvert.

Grooving the Ties for Rails.



Bridge Over the Jaia River, Central Siberia. Showing Excellent Character of Masonry Pier and Steel Superstructure.

Track Laying on the Trans-Siberian Railroad; Note the Cheap, Half-Round Ties.

THE TRANS-SIBERIAN RAILWAY.

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Purification of Potable Water by Means of Ozone.

The purification of potable water by means of ozone formed the subject of an interesting lecture delivered by Dr. G. Erlwein, of Berlin, at the forty-third annual meeting of the German association of specialists in gas and water technology at Zurich, the essential points of which are given below.

The lecturer first discussed the practicability of the use of ozone in the purification of various kinds of water (surface and underground water) in municipal or central water-works, and the advantage of this method over the various proposed methods of purifying water by chemical means. He then gave a description, illustrated by diagrams and models, of Siemens' ozone works at Paderborn and Wiesbaden, which have been described by him in the SCIENTIFIC AMERICAN. The lecturer then pointed to what had been accomplished by the method as regards the destruction of bacteria, and showed results obtained by the Imperial Health Bureau (Ohlmuller) and by Koch's institute for infectious diseases (Proskauer-Schuder), also by Siemens & Halske in experimenting on ordinary and pathogenic bacteria in their experimental works at Martinikenfelde, and in the water-works at Wiesbaden. Special attention was directed to the main result arrived at, viz., that ozone practically reduces the ordinary water-bacteria to a minimum, and may be absolutely relied upon to destroy pathogenic bacteria of every nature, even in the most contaminated water.

Dr. Erlwein then tried to give his audience an idea of the expense attending the working of the system, and submitted a statement showing in detail the cost of treating one cubic meter of water in establishments of different working capacity and working under different conditions. Figures were given showing the comparative cost of working in establishments (*a*) of different working capacity (2,000 and 200 cubic meters per hour respectively), (*b*) working different hours (12 and 18 hours daily), and (*c*) with different kinds of motive power (gas and steam).

Before concluding his lecture, Dr. Erlwein described the systems of sterilization in vogue in other countries, using drawings, illustrating the principles of construction of the sterilization tower and of the ozone apparatus. The following systems were mentioned:

1. Siemens & Halske's older type of 1890 had an iron tower about 3 meters high, filled with water, through which ozone air is forced.

1a. Scrubber's tower was 4 meters high, filled with pebbles.

2. Tindal's tower was 8 to 10 meters high, with a series of rainfalls through which ozone air is passed. Another type of Tindal's tower consists of three to four wide earthenware pipes joined together in a row for the passage of water, into which ozone air is forced.

3. Abraham-Marmier's scrubber, about 4 meters high, the interior construction and contents of which are not known.

4. Otto's tower, in the upper division of which the ozone is mixed with water by means of an injector. The lower division is fitted with a scrubber, with a view to utilizing the unconsumed ozone.

5. Vosmaer's tower; an iron cylinder with a water column, through which a counter-current of ozone-air is forced.

Other systems mentioned were:

1a. Siemens & Halske's latest type, as used at Paderborn and Wiesbaden, with a discharge surface consisting of eight cylindrical pipes; outer positive electrode cooled by water; it carries a current of about 8,000 volts, one pole being grounded.

2a. Tindal's ozone apparatus with discharge surface of metal resistant to ozone. A Schneller glycerine-alcohol resistance is inserted into the high-tension circuit to produce a sparkless short-circuit-proof ozone discharge without insulation. The discharging surfaces of one electrode are the inner walls of a cooled double-walled metal box resting on the ground, the corresponding surfaces of the other being formed by insulated metal plates placed in the box. Current: 40,000 to 50,000 volts.

3a. Abraham-Marmier's box, with a series of glass plates, one square meter in size, as discharging surfaces. Both electrodes are cooled by water, and the cold water current is provided with two rainfall interrupters for the insulation of the high-tension pole. Current: 40,000 volts. A spark gap is inserted into the high-tension circuit for generating currents of high frequency.

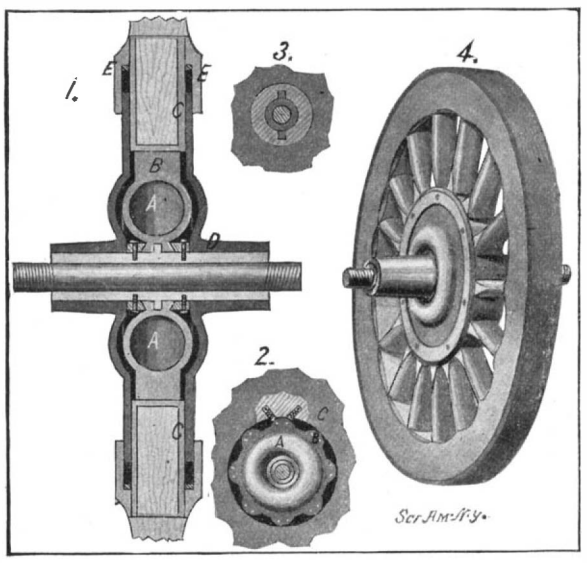
4a. Otto's apparatus. One pole is formed by the iron cylinder, resting on the ground, and the other by a concentric rotating metal axis with vertical aluminium disks. Current: About 12,000 to 20,000 volts. The discharges take place between the inner surface of the iron cylinder and the edges of the rotating aluminium disks without fixed insulation.

Vosmaer's ozone apparatus, with a grounded pole, has not been drawn, as the details of its construction are not known. It is said to consist of a system of combined iron tubes, between which the discharges take place without a fixed insulator. Current: 10,000 volts.

In conclusion, the lecturer discussed the prospects of the use of ozone in municipal or central water-works, and pointed out that the practical application of the treatment would be limited to the purification of surface water, the purification of underground water being only necessary in certain special cases, and appealed to water technicians to co-operate in insuring the success of the new process by developing its technical side as thoroughly as hygienists had developed the scientific idea. In the SCIENTIFIC AMERICAN SUPPLEMENT Dr. Erlwein's lecture will be published in full with drawings.

RESILIENT WHEEL FOR VEHICLES.

It has occurred to Mr. Brenton B. Weaver, of Glace Bay, Cape Breton, Nova Scotia, that by placing a resilient tire in the hub of an automobile wheel instead of on the tread where it is subjected to constant wear, the difficulties which now attend the use of pneumatic tires on automobiles would be entirely avoided. The construction of this wheel is shown in the accompanying illustration, in which Fig. 1 shows a section through the center of the wheel hub. The resilient member is indicated at *A*, and consists of a hollow tube of rubber provided along its periphery with a series of ears *B*, as best shown in Fig. 2. The tube lies in a recess formed in the hub casing and is separated from the axle by a bushing. Two metal rings are bolted to this bushing and they are formed with inclined walls to fit over a bead formed on the inner surface of the tube, thus holding the tube firmly in place. The bushing is also provided with two lugs which fit into sockets formed in the tube, thus preventing the latter from creeping. The hub, it will be observed, is formed of two flanges or circular plates, between which the ring *C* is held. Two flanges *E* are



RESILIENT WHEEL FOR VEHICLES.

secured to the ring and these fit over the flanges of the hub *D*. The ring rests along its inner edge on the ears *B* of the rubber tube which is held from moving circumferentially thereon by coil springs. The ring *C* is formed at intervals with sockets to receive the spokes of the wheel. When the wheel is in use any jolting caused by unevenness in the road will be taken up by the cushion tube *A*, the ring *C* being permitted to move between the confining flanges of the hub. As an extra precaution a rubber ring is placed in the bottom of the trough formed between the flange *E* and ring *C*, so as to prevent undue jarring of the parts should the edge or flange *D* be brought into contact therewith.

The Current Supplement.

Mr. Emile Guarini opens the current SUPPLEMENT, No. 1476, with an interesting article on "Automobile Fire Engines." The excellent discussion of radium begun in the last SUPPLEMENT is continued. The recently announced discovery of a new substance called by its discoverer, Prof. W. Marckwald, "Radio-Tellurium," has been made the subject of some interesting letters in Nature by Mr. Soddy and Prof. Marckwald. These letters on radio-tellurium are published in the SUPPLEMENT. "Our Flood Warning Service" is the title of an article by Charles A. Byers. Mr. I. C. Russell writes instructively on the recent volcanoes of southwestern Idaho and southeastern Oregon. His paper is accompanied by striking illustrations. Mr. Herbert C. Fyfe writes on a "New Invention for Rendering Vessels Unsinkable." Mr. E. O. Hovey discusses the "Crystal Cave of South Dakota."

The Atchison, Topeka & Santa Fe Railroad has purchased the Cane Belt Railroad, running from Sealy, Texas, to Matagorda, 90 miles. The building of a line to be called the Eastern Railway of Mexico, which will be about 500 miles long, and cost $13,000,000 to $14,000,000, is contemplated; also a line north from San Francisco.

Engineering Notes.

The Midland Railway Company is introducing a number of steel wagons of a novel pattern, which have been designed for either coal or ordinary merchandise traffic. Some of these trucks have been erected at the Derby works, while others have been built by the Leeds Forge Company. The wagons are 17 feet 6 inches in length (inside), 4 feet 6 inches in depth (inside), 7 feet 9 inches in width (inside), 8 feet 4¼ inches high from the rails, with a carrying capacity of 15 tons. Considerable economies will, it is claimed, be effected by having wagons which can be used for either coal or goods traffic.

North of the Thames the railways of London serve an area of 433 square miles, with a population of more than 4¼ millions. On the south the area served is 259 square miles, with a population of over 2¼ millions. In the former case there is just over three-quarters of a mile of railway for every square mile, and in the latter case just over one mile, the number of passenger stations per unit area being approximately the same in both cases, but in the northern district nearly 13,000 inhabitants have to be served per station, in the latter case 1,200 less. The inward trains on the northern section per week-day are 2,582 and on the southern 2,115, altogether 4,697. An examination of these figures shows that the south side of the Thames is better served than the north.

A pneumatic sanding device has been devised by an American company for electric street cars fitted with air brakes. It is simple, and consists of two traps placed beneath the sand-box. From each trap a rubber hose connects with a 1-inch iron pipe. The air supply is taken from the main reservoir, from which it passes through the motorman's valve with the warning port of the traps. The sand is then lifted from the traps and blown between the tread of the wheel and the rail. The operating valve in the cab is fitted with a warning port, and is so constructed that when the sander is in operation the warning port keeps up a continuous whistle. Should, however, the motorman wish to stop the whistle and still desire to keep the sander in operation, he can do so by simply pressing on the valve placed in the end of the operating valve handle.

A note presented to the French Academy describes an "electro-mechanical" coupling which allows a continuous change of speed from zero to maximum speed, and which is specially suitable when the prime-mover is near the axle to be driven. It consists of a combination of the prime-mover with two dynamos, one running as generator, the other as motor, and both being of a much smaller capacity than the prime-mover, say 1-3 or ¼. The prime-mover transmits always a certain part of its power directly to the main axle to be driven, while the rest of its power is absorbed by the electrical machine which runs as generator. A train of epicyclic gearing is used in such a way that the main axle is acted upon simultaneously by both the prime-mover and the dynamo which runs as motor. These two machines are separate, and may consequently have different speeds. For instance, an epicyclic gearing may be composed of a central toothed wheel and an external wheel with inside teeth, with toothed wheels between the two. The axles of the latter are fixed on a support. The desired result is obtained by connecting each of the three parts (internal wheel, external wheel, and support of the middle wheels) with one of the three axles—that of the prime-mover, that of the electric motor, and the main shaft respectively.

There is no doubt that one of the most important matters awaiting attention in the present day is the improvement of the existing canal systems, which might be reorganized to the great benefit of trade and commerce. A complaint frequently made by manufacturers is that they are seriously handicapped in competition with foreign rivals by excessive railway rates. Agitation sometimes results in the granting of small reductions, but still no substantial relief is given, nor can it be expected. The liberation of the canals from the stifling control of the great railway companies would be the first step toward affording the necessary relief, but considerable alterations in the existing waterways would be necessary before they could be of much use. An excellent scheme for the reconstitution of the canals has recently been submitted to the members of the Liverpool Chamber of Commerce, and there really seem to be no engineering difficulties to prevent its realization. The proposal is to make the canals at least 6 feet deep, with an average width of 80 feet, and to provide them with locks 235 feet long by 32 feet wide, large enough for a tug and five barges to pass at one time. The scheme in question relates to the improvement of 240 miles of canals connecting the most important manufacturing and mercantile districts of Great Britain. The cost would be no doubt heavy, but the benefit to be reaped in the reduction of freight charges would probably be sufficient to justify the necessary expenditure.

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Correspondence.

A Carolina Ostrich Farm.

To the Editor of the SCIENTIFIC AMERICAN:

I notice in SCIENTIFIC AMERICAN, issue of April 2, page 275, an article by Day Allen Willey on raising ostriches and mentioning only two farms. From the California farm there is a branch ostrich farm in Asheville, N. C., where for three years they have been quite successful in raising the birds and manufacturing and selling plumes. J. M. STONER.

Asheville, N. C., April 6.

Why Does Popcorn Pop?

To the Editor of the SCIENTIFIC AMERICAN:

1. Why does popcorn "pop"?
2. Why does not ordinary corn pop like popcorn?
3. What is the composition of popcorn, and how does it differ from ordinary corn?
4. Why does popcorn pop better when thoroughly dry? R. BAILY CARSON.

Knoxville, Ill.

1. The popping of popcorn is due to the volatilization of the oil content in the kernel.

2. Field corn does not pop as readily as popcorn, because the outer portion of the kernel is more porous, permitting the escape of the oil as it volatilizes; while in the case of popcorn a great pressure is developed in the kernel by the confined oil, and the kernel is suddenly exploded and turned wrong side out.

3. In composition popcorn differs from ordinary corn in having a larger proportion of the corneous element and a greater per cent of oil.

4. Popcorn pops more readily when dry because when moistened the kernels are swollen, more porous, toughened, and do not explode so suddenly and completely as when dry and hard. C. P. HARTLEY.

Assistant in Physiology, Bureau of Plant Industry, Department of Agriculture, Washington, D. C.

Dr. Draper's Speculum Test.

To the Editor of the SCIENTIFIC AMERICAN:

Referring to articles and letters on the above subject in SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 1306 (1901) and 1450 (1903), and in SCIENTIFIC AMERICAN, November 13, 1903, and March 26, 1904, I wish to say that Mr. James A. Smith is correct and that Dr. Draper and myself are wrong.

I beg Mr. Smith to accept my regrets for the error, and my humble apology for my contradiction, and also thank him for his valuable correction.

Longitudinal aberration in most mirrors being but small, and all practical opticians finishing their work by actual trial on a star is, I presume, the reason that the error has escaped notice so long. I find that the outstanding aberration in Dr. Draper's 15-inch specula would amount to less than 1-20 of an inch; and as he admits that most of his reflectors were over-corrected (by his test), of course the actual error would be less still; so that it is hardly surprising that it escaped his notice, the more so as other considerations—as the obliqueness of the pencil, the difficulty of determining the *exact* focus of a narrow zone near the margin, the disturbance due to heat waves in a close cellar, as well as diffraction troubles—make it undesirable to rely upon the test *exclusively*, though it is invaluable in determining if a surface is uniform, and for detecting irregularities and other imperfections.

I never found any advantage in using so small a hole as Mr. Smith recommends.

EDMUND M. TYDEMAN.

Camden, N. J., April 4, 1904.

Commercial Japan.

"Commercial Japan in 1904" is the title of a monograph just issued by the Department of Commerce and Labor through its Bureau of Statistics. It shows that the trade relations between the United States and Japan in recent years have grown with greater rapidity than between Japan and any other nation.

In 1881 the imports from the United States formed less than 6 per cent of the total importations into Japan, while in 1902 they formed nearly 18 per cent of the total importations. Meantime Great Britain's share in the imports of Japan fell from 52 per cent to 18 per cent in 1902. The United States is also Japan's largest customer, by reason of the fact that the chief export products of Japan are articles required by the manufacturers of the United States, and which can not be produced in this country. The total exports from Japan in 1900 amounted to 204,429,994 yen (yen is equal to 51 cents, United States currency) in value, and of this amount 52,566,395 yen went to the United States, 39,171,455 to Hongkong, 31,871,576 to China, 19,150,423 to France, and 11,262,997 to the United Kingdom; the total exports of 1902 amounted to 258,303,065 yen, of which 80,232,805 yen in value went to the United States, 25,876,059 to Hongkong, 46,838,545 to China, 27,283,458 to France, and 17,346,149 to the United Kingdom.

The exports of Japan to the United States, as already indicated, are chiefly articles which are not produced in this country, and in a majority of cases are those required by our manufacturers. Of the 80,232,805 yen in value exported to the United States in 1902, the value of 46,784,720 yen consisted of raw silk, 8,921,995 yen manufactures of silk, 9,124,085 yen of tea, 6,381,733 yen matting for floors, 577,888 yen rice, 1,516,401 yen chemicals, drugs, etc., while manufactures of bamboo, lacquered ware, and other products peculiar to the Japanese have also figured largely in the list. Exports of raw silk from Japan to the United States have steadily grown, especially since the development of the silk-manufacturing industry in this country. In 1893 the value of her raw silk exports to the United States was 11,078,748 yen; in 1894, 22,457,348 yen; in 1895, 27,826,245 yen; in 1896, 14,080,981 yen; in 1897, 32,262,900 yen; in 1900, 26,710,050 yen; and in 1902, 46,784,720 yen.

Of raw silk from Japan, the total exportations exceed 50,000,000 yen annually, of which the United States is the largest purchaser. France is the next largest customer in this line, her purchases of raw silk from Japan in 1902 amounting to 14,682,816 yen in value, against 46,784,720 yen by the United States, while Italy took raw silk to the value of 12,261,383 yen, England, 564,948 yen, and Russia, 776,759 yen. The total exports from Japan to the United States in 1881 were 11,056,464 yen in value, being 36.5 per cent of the total exports of that year, and in 1902 were 80,232,805 yen, or 31.06 per cent of the total exports.

Japan's imports from the United States have grown with even greater rapidity than her exports to the United States. In 1881 they amounted to but 1,781,108 yen, and in 1900 had reached 62,761,196 yen in value. Proportionately they have grown with much greater rapidity than the total importations of Japan, our share of her import trade having increased from 5.72 per cent in 1881 to 17.91 per cent in 1902, while the United Kingdom, our principal competitor in that market, which furnished, in 1881, 52.57 per cent of the total imports of Japan, supplied, in 1902, 18.53 per cent. A detailed examination of the supplies furnished by the United States to Japan can perhaps be better made from our own standpoint measured in dollars. In the fiscal year 1892 our total exports of domestic merchandise to Japan amounted to $3,288,282, and in 1902 to $21,139,726. Of this total, the largest item of export was raw cotton, which aggregated $9,058,290, the next largest item being illuminating oil, with a total of $5,195,665.

Third in rank is manufactures of iron and steel, with a total of $1,923,607, other important items being breadstuffs, $1,296,615; provisions, $196,337; scientific instruments, $314,734; leather and manufactures, $322,729; tobacco and manufactures, $509,921; clocks and watches, $115,386; paper and manufactures thereof, $187,860; lubricating oil, $187,138, and paraffin, $311,920; while many other articles of less importance have found a place in the markets of Japan. Taking up the great class of iron and steel and examining its details, it is found that the exports of locomotive engines in 1902 amounted to $129,352 in value; builders' hardware, $106,651; sewing machines, $15,980; firearms, $9,513; car wheels, $11,955; other machinery, $734,696; and miscellaneous manufactures of iron and steel, $915,460.

The exports of raw cotton have grown from but $85,211 in 1890 to $9,058,290 in 1902. Illuminating oil, the exports of which amounted in 1890 to $3,559,395 in value, showed in 1902 a total of $5,195,665, despite the active competition of Russian and Sumatran petroleum, and the further fact that Japan is now herself supplying a part of her consumption of illuminating oil. Exports of flour increased from $127,120 in 1890 to $1,279,880 in 1902. This increase is evidently due to a growing disposition among the Japanese to consume more of this class of food rather than to rely upon rice, as in former years, since the number of foreigners in Japan other than Chinese and Koreans amounts to less than 4,000, and has not materially increased during the period in which our exports of flour to that country have increased sevenfold.

In paper and manufactures thereof our export trade with Japan has grown very rapidly, the total exports in this class being, in 1890, $1,606; in 1896, $10,126; and in 1902, $187,860. Instruments for scientific purposes increased from $9,441 in 1890 to $34,600 in 1894, and $314,734 in 1902. In 1890 the value of the canned beef exported from this country to Japan was $11,212; in 1902 the total was $8,399; while exports of pickled beef advanced from $638 in 1890 to $3,536 in 1902. Leather and manufactures of leather find a steady demand in Japan, owing to the fact that the number of cattle and other animals whose skins are used for tanning is comparatively small; the total number of cattle in Japan, according to the last census, being but 1,282,341, or 28.62 for each 1,000 inhabitants.

Exportations of cotton cloths to Japan have fallen by reason of the rapid increase of the manufacture of cotton cloth in that country, the total for 1902 being but $48,803 against $141,264 in 1897. Meantime, however, exportations of raw cotton to Japan have rapidly increased, being, as already indicated, $9,058,290 in 1902 against $85,211 in 1890. This is largely due to the increase in the manufacture of cotton goods in Japan, though American cotton has grown in popularity with the manufacturers there within the past few years. Experience has shown them that cotton from the United States is more satisfactory for use in manufacturing than that which Japan had been accustomed to obtain from India and China, the staple in American cotton being longer, thus giving better results. The cotton of India, however, sells at a lower price than that of the United States, and therefore still finds a large market in Japan in years of plentiful supply. Japan also produces a considerable amount of cotton, though it can scarcely be expected that this will increase in a manner to at all keep pace with the growth of her cotton manufacturing industry. The entire area of Japan is but 161,159 square miles, or less than the State of California, while but about 12 per cent of the land is under cultivation, and but a comparatively small proportion cultivable, since mountain ranges and rocky islets and shores occupy a large proportion of its area. It must be remembered that Japan, with her small cultivable area, has a population of 44,805,937, and must therefore devote most of her arable land to the production of food stuffs, while her natural products of silk and tea are so much in demand the world over that they are not likely to be displaced for cotton, which can be so readily brought from other and comparatively adjacent countries. Cotton manufacturing in Japan has, however, grown very rapidly, the total number of spindles in 1899 being 1,170,327 against 5,456 in 1863. It is thus apparent that Japan will continue to purchase from other parts of the world a large proportion of the raw cotton which her rapidly-growing cotton mills will consume, and as the cotton from the United States has already made headway against that from the nearer countries of China and India, it is reasonable to assume that the market for American cotton will continue to grow, especially if an Isthmian canal gives opportunity for direct water shipments from the cotton-growing section of the United States to the ports of Japan without breaking bulk.

Dry Bananas.

BY S. E. WORRELL.

Ripe peeled bananas only weigh about forty-five per cent of the full bunches, while the dried product, retaining all its flavor and nutrition, only weighs approximately one-ninth as much as the bunches, and has nearly the same reduction in space. These features alone will save a large amount in the cost of transportation and cold storage of the fresh fruit. It is impossible to grind dried bananas into flour, as they are about as tough as evaporated apples, but they may be prepared in two styles; either to press them into barrels or boxes, just as they leave the drier, or chop them up fine with a large sausage-meat cutter, and pack them in attractive one-pound paper packages. In the latter shape they will make an excellent breakfast food, and can be used for cakes, puddings, ice creams, and numerous other purposes. Also, if heavily compressed in a small space, they will make an ideal ration for soldiers or travelers on long inland tours. Unquestionably bananas embody more nutritious matter than any other fruit, not excepting dates, which, while they are rich in sugar, contain little starch or gluten, and also have large seeds. It is said that an Arab can cross a desert on a pocketful of dried dates for food. We must take this statement with considerable allowance, or else believe their barren lands are very small or their pockets are of unusual dimensions. I would take a pocketful of dried bananas in preference.

I see no reason, if this evaporated fruit is put up in insect-proof packages, why it will not keep for years in any climate, so it can be safely and cheaply transported to any part of the earth. As is well known, the fresh fruit is the most expensive to ship. Owing to the long voyages and its delicate nature, it must be very carefully handled to prevent bruising, and requires cold storage, so as not to ripen too soon. The saccharine and gluten contents of bananas naturally cause a little more difficulty in their evaporation than common fruit, but I believe this can be overcome by some changes in our best driers. I would advise the adoption of mechanically-forced hot-air currents, which will nearly double their capacity and shorten the operation, thus furnishing a brighter colored product, which increases its value. I also believe it will be necessary to substitute perforated sheets of non-corrosive metal for the bottom of the drying trays instead of the usual cheap galvanized-iron wire cloth.

The best evaporated fruit retails here at from ten to fifteen cents per pound, but dried bananas ought to bring higher prices, owing to their fine flavor and the fact that they require no sweetening.

From these reasonable conclusions it would appear if this business, gone into on a large scale with ample capital, some of which must of course be expended in judicious advertising and careful management, promises permanent and profitable returns.

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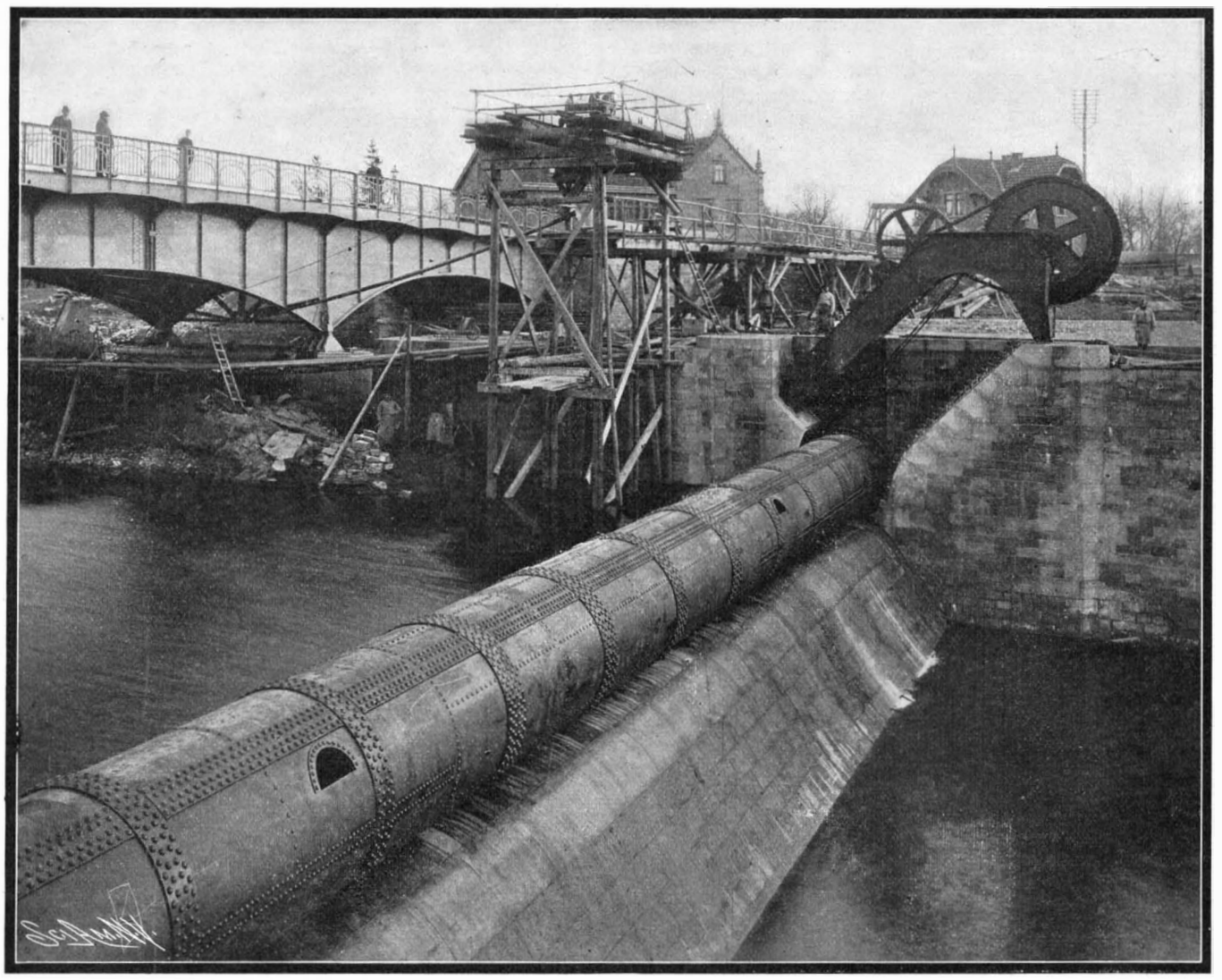
THE CYLINDRICAL MOVABLE DAMS AT SCHWEINFURT, GERMANY.

BY A. STEENS.

The city of Schweinfurt, on the river Main, can boast of a type of dam which must surely present to engineers features of construction and operation that are undoubtedly novel. Two dams have been constructed, both cylindrical in form and arranged to be lifted bodily above the water. They were built partly to render the stream above them navigable and partly to divert the water for power utilization. As the river is one subject to heavy floods, a type of dam that would permit a very rapid discharge of the freshet water had to be designed, and the cylindrical form, arranged to roll upward above the flood level, was adopted. To demonstrate fully its practicability, the first dam was constructed across a secondary branch of the river at Schweinfurt, with a total length of 59 feet and a diameter of 13.58 feet. The satisfactory operation of this led to the construction, across the main branch, of the dam shown in the engraving. This is 115 feet long and 6.56 feet in diameter. Briefly, it is a hollow cylinder of sheet steel, on each end of which is fixed a toothed wheel which meshes with an inclined rack built in each abutment.

The dam as a whole consists first of a sill upon which the cylinder in its lowermost position rests. This cylinder is 6.56 feet in diameter and extends from shore to shore, a distance of about 35 meters (116 feet). When lowered, this enormous cylinder effects a rise in the river of 6½ feet.

Among the conditions first established, and under which the dam was to be constructed, we find a section declaring that there were to be erected in the stream no piers or other supports that might interfere with the free movement of the ice in the spring. Not even temporary supports that could be removed upon the general breaking up of the ice or even at the close of navigation, were allowed, simply because in order to insure their stability, foundations, or the like, would have been necessary to sustain them, and these would become permanent obstructions likely to be damaged by freshets.



CYLINDRICAL DAM ACROSS THE RIVER MAIN, SCHWEINFURT, GERMANY.

The first dam designed differed materially from the second in the method of raising the cylinder. It was designed to be hauled upward from its lowest position by cables on each end. In the second, later dam, the driving mechanism is all located at one end. Our illustrations clearly show this. When the downstream level of the water rises, the pressure would have a tendency to lift the gate. The cylinder itself is watertight, to prevent the freezing of the water which might otherwise collect in it. Still an interior pipe is provided in the smaller dam open at each end of the dam, but shielded by its interior location from the cold. This pipe is filled with water to secure greater stability. The racks in the case of the second larger dam are placed at an angle of 45 degrees. The cylinder, in its lowest position, rests on a sill of oak and the tightness of the dam at each end is provided for by a band of leather around the periphery. The pressure of the water holds the leather against the sill. The weight of the movable cylinder of the first dam is 158,400 pounds. To bring it above the level of the highest flood it is necessary to raise it a distance of 16.4 feet. It is arranged for hand working, with six men on each side. Assuming that each man can perform work equivalent to 57.75 foot-pounds per second (8 kilogrammeters), and allowing for an efficiency of 35 per cent in the hoisting mechanism, the time required to lift the cylinder the given distance is determined as follows, remembering that twelve men are engaged all told: $158{,}400 \times 16.4 \div (57.75 \times 12 \times 0.35) = 10{,}710$ (seconds), or 3 hours. To lift the cylinder above ordinary freshets, only about half this time is consumed.

The larger dam was begun in May, 1903, and was put in service in December. Its rollway length is 114.8 feet, but its actual length is 121.3 feet, 3.28 feet of each end extending into the masonry of the abutment. The steel is 1.1 inches thick, built in sections 9.84 feet long with a single longitudinal joint. The transverse joints are butt joints, each section being reinforced in the middle by a brace contributing to its rigidity. This cylinder is watertight except in two chambers in the upper part at each extremity. When the downstream water level does not rise more than 3 feet or so above the bottom of the dam the weight of the cylinder is sufficient to counterbalance the pressure; but when the water level rises above this limit, the water enters the two chambers, giving the cylinder added stability. The racks in the case of this dam are inclined at an angle of 45 degrees only along the upper part. Toward the bottom, the pitch is increased, attaining 4 to 1. This increase in pitch is made on a radius of 10.46 feet. The steepness of the bottom part of these racks gives the dam better bearing against water pressure tending to raise it. The weight of the cylinder is 193,600 pounds.

The operating apparatus includes two steel cables of 1.8 inches diameter, each formed of six strands. The two cables are rolled on drums, and to raise the cylinder above high water, that is to say, 13.12 feet, an electric motor of 18 horse-power is employed, and the operation takes less than a quarter of an hour. The mechanism is also provided with four cranks, by means of which the dam can be lifted by hand. The cranks drive a worm gearing through chains, and this, in turn, meshes with a train of gears and a chain to the hoisting drums.

A special commission selected by the French naval authorities, after prolonged investigations and experiments with the turret guns of the battleship "Henri IV.," has condemned the existing arrangement of the turrets, owing to the fact that the firing of these particular guns constitutes a serious menace during discharge to the crew attending to the guns in the lower turret beneath them. In one experiment four sheep were tied to the lower turret in the places that would be occupied by gunners in action. Ten rounds were then fired from the upper turret guns, and when the animals were subsequently examined, three were found dead as the result of the concussion, while the fourth had broken loose and sought refuge in the captain's cabin. Even allowing for the fact that men are able to resist shock to a far greater degree than sheep, such a result proved that the upper turret guns would exercise a dangerous, if not entirely fatal effect, upon the gunners in the turret immediately below.

British Ship "Discovery" Back After Two Years in the Ice.

The steamer "Discovery," which conveyed a British exploring expedition to the Antarctic Ocean, sailing from London in July, 1901, arrived at Lyttleton on April 1 after having been in the ice for two years.

The "Discovery" was accompanied by the relief ships "Morning" and "Terra Nova." The relievers found the "Discovery" on February 14. The crew is well.

Among the results of the expedition is the discovery of a new route to the westward. Parties from the vessel climbed to the summit of Victoria Land, which they describe as a vast plain 9,000 feet above the sea level. Their observations show that the great ice barrier is stationary. The expedition obtained much new scientific knowledge.

The Daily Mail's correspondent at Christchurch, New Zealand, says that in an interview Capt. Scott, the commander of the "Discovery," gave an interesting narrative of the experiences of the expedition, but disclosed nothing of a remarkable nature. In instancing the severity of the Antarctic weather he said that records of 100 degrees of frost were obtained in May, 1902.

Detailed information was obtained of the exact point of the junction of the barrier ice and the land. A depot was established there, and members of the expedition who visited it twelve months later found that it had moved a quarter of a mile to the northward. Capt. Scott described the glacier valley in South Victoria Land as presenting magnificent scenery. Some plant remains were discovered.

The relieving parties arrived at the edge of the ice on January 1, but although the ice began to weaken soon after, it was not until February 14, with the help of dynamite, that the "Discovery" reached open water and joined them. While subsequently traversing the coast line it was ascertained that Balleny Islands and Russell Islands were identical.

The islands reported to be in the meridian of about 156 proved to be non-existent. A shortage of coal compelled the expedition to return earlier than was intended. The "Discovery" reached Auckland Island on March 15 with only ten tons of coal in her bunkers.

Capt. Scott describes the results of the expedition as eminently satisfactory. Everybody is in perfect health.

The Recent Earthquake at Lima.*

The earthquake occurred on the 4th of March, at 5.20 A. M. If it had lasted a few seconds more it would have completely ruined the city. It was a terrible earthquake, lasting fifty seconds, and it produced a general panic. Three or four lives were lost, and a great many wounded, and it is estimated that in Lima the loss amounted to one million *soles* (about $500,000).

Aged persons cannot recollect having felt a similar commotion, and it is a wonder it has not caused a great deal of damage. It was felt with greater intensity at Chorrillos, in which the walls of summer residences have been rent almost generally, and some have become uninhabitable. In Callao, too, a great number of houses and public buildings are in bad condition.

In Lima the churches suffered considerably, and many private houses were rent, the corners being split apart. Public edifices did not suffer. The citizens of Lima are anticipating a worse shock for September.

* Translation of a private letter from Lima, Peru, under date of March 14, 1904, to Mrs. A. F. Bandelier.

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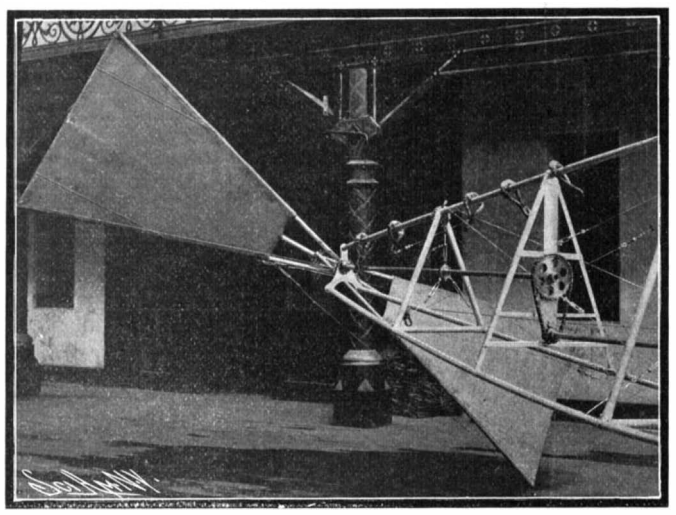
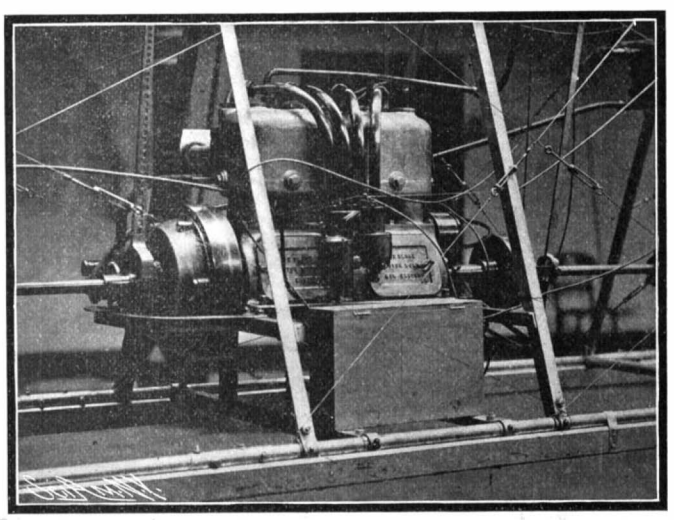
THE BEEDLE AIRSHIP.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

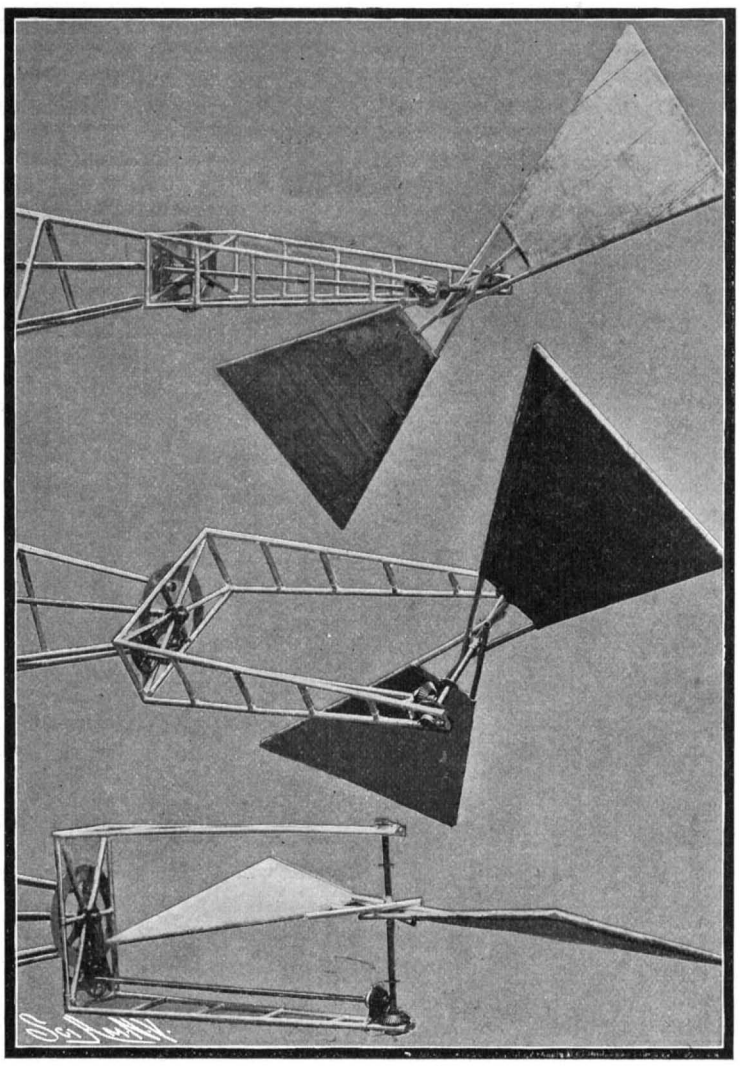
The accompanying illustrations show the frame, propellers, and motor of an English airship having one particularly novel feature. The frame of the ship, as is well shown in the photograph, is built of steel bicycle tubing. The three main tubes extend the whole length, and are brought to a point at each end. The frame is arranged so as to form a triangle, within which is placed the motor and the aeronaut's basket. The total length of the framework is 50 feet. The three longitudinal tubes are connected at intervals of about 4 feet by horizontal cross tubes between the bottom members of the frame, and by inclined t bes between the two bottom members and the top tube. The whole frame is also stiffened and braced by steel wire.



The 12-foot Rear Propeller.

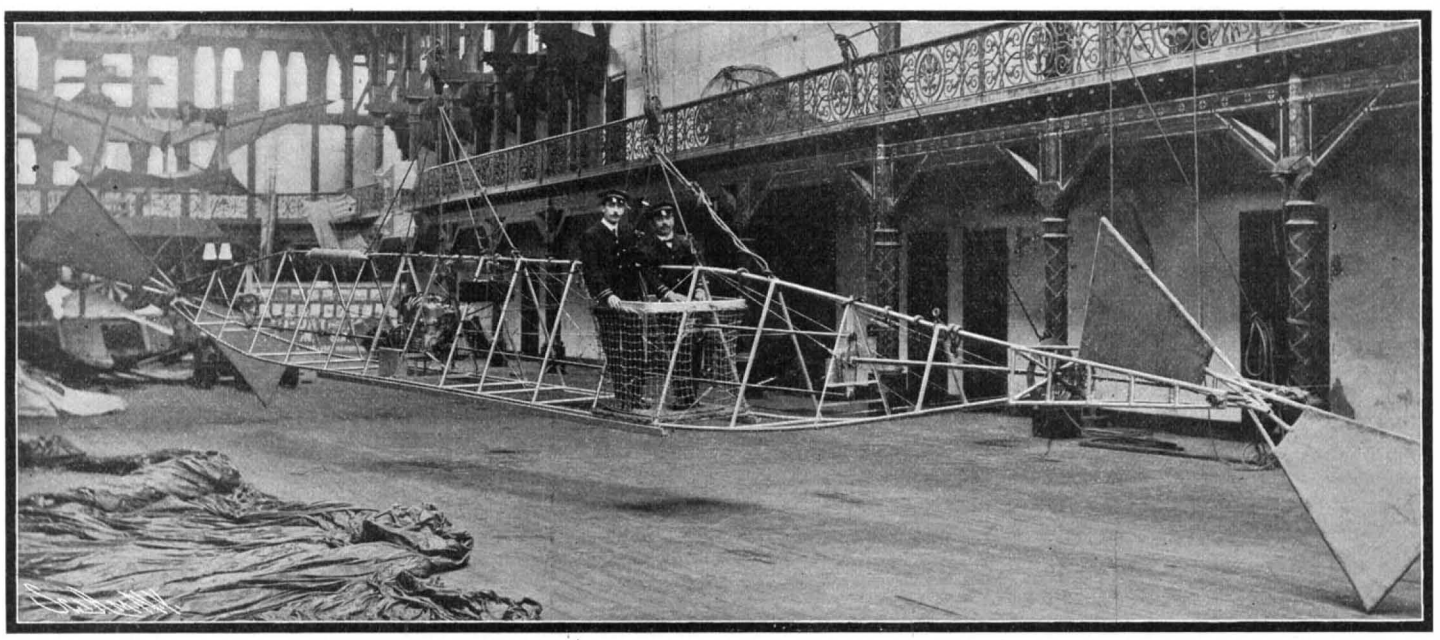


The 15-H P. Motor of the Airship, Showing Flywheel and Internal Cone Clutch.



Three Views of the Steering Propeller.

(1) Vertical position for steering; (2) Inclined position; (3) Horizontal position for moving up or down.



THE FRAME OF THE BEEDLE AIRSHIP, SHOWING ARRANGEMENT OF MOTOR, PROPELLERS, AND AERONAUT'S BASKET.

The inventor is the right-hand figure.

The motor is contained in a central frame, the weight of which complete, with the motor mounted, is 417 pounds. The weight of the entire frame of the airship is about 860 pounds.

The motor is a standard four-cylinder, 12 to 15 horsepower, Blake gasoline engine. To keep down the weight, aluminium has been utilized as much as possible in its construction. The arrangement of the motor, with its flywheel and disconnecting clutch at one end, and with its other disconnecting clutch at the other end, is well shown in our illustrations. Four inlet pipes lead from the carbureter to the inlet valves of four cylinders. The cylinders are cast in pairs, with a common water jacket for each pair.

The great feature of the Beedle airship is the steering propeller, which is mounted at the front end of the framework. The propeller is carried on a cross shaft at the front end of a trussed U-shaped frame. This frame can be revolved on a sort of vertical turntable or fifth wheel, and it is readily turned by means of a crank. The shaft carrying the propeller is driven through bevel gears by a driving shaft running along one side of this frame, and which is in turn driven by a spur gear and pinion from a central shaft turned by the motor. When it is desired to direct the airship upward, the propeller-carrying frame is placed in a vertical position (as shown in the lower photograph), thus placing the propeller in a horizontal position and causing it to employ its thrust in aiding the airship to rise. As soon as the desired height has been attained, the propeller is turned to a vertical position, and it then can be used to steer either to the right or left, according to the direction in which its thrust is aimed. Should it be necessary to use the propeller for bringing the airship to earth, if it is placed in the horizontal position with its thrust directed upward, it will tend to lower the airship. The diameter of the steering propeller is 8 feet, while that of the propeller proper at the rear of the airship is 12 feet. The latter propeller is driven continuously, while the steering propeller is used only intermittently, as needed. The long, longitudinal driving shafts, running fore and aft from the motor, are arranged to run in special self-aligning ball bearings, and there is a considerable speed reduction from these two driving shafts to the propeller shafts, as can be seen in the illustration. The airship is controlled by four levers, placed within easy reach of the aeronaut. Two of these levers operate the clutches, and the other two regulate the throttle and ignition of the motor. A compass is also placed above the steering wheel.

The balloon, which is cigar-shaped, is 93 feet in length and has a capacity of 26,000 cubic feet of gas. No ballonette is used within the balloon proper, and the latter has only sufficient buoyancy to just lift the frame, machinery, and aeronaut, as Mr. Beedle depends upon his propeller steering device to raise or lower the ship. This device makes it unnecessary to liberate gas in order to descend. The Beedle airship is a possible competitor at the St. Louis Exposition contest.

Ninety thousand gallons of water will pour over the three cascades at the World's Fair every minute.

The Second Annual Test of Commercial Automobiles.

The annual test of commercial automobiles, conducted by the Automobile Club of America, was held last week in this city. Instead of a mere parade of the contesting machines, with stops, interspersed somewhat as in actual use, the trucks and delivery wagons were this year placed at the disposal of two express companies and were thus engaged in making deliveries and collections under actual conditions of service.

Eighteen machines were entered in the test, and all but one started. Two dropped out after one day's work. One of these was a new gasoline delivery wagon that had been completed only the day before and that had received no proper testing. The other was a large 7-ton steam truck, intended to carry a load of 5 tons. This machine made a trip to Yonkers the first day, and did not reach home again till 1.55 P. M. the following day, when it dropped out on account of the boiler not working well. The only other large truck was the Fisher gasoline-electric. This also was intended to carry 5 tons. On the fourth day of the test it carried 10,200 pounds of beer to Yonkers and returned with 4,200 pounds of empty barrels in exactly 9 hours. The total distance was 32 miles. On the same day a Pope-Waverley electric light delivery wagon made 35⅛ miles on a charge. A load of 1,000 pounds was carried and 100 stops were made in 10 hours, 55 minutes. The average distance covered by the gasoline delivery wagons was about 35 miles, and that made by the electrics about 28. There were five gasoline wagons intended for a load of 2,000 to 2,500 pounds; one gasoline truck for a 4,000 pound load; three electric wagons capable of carrying 2,000 pounds; one electric truck intended for a load of 5,000 pounds; two light electric delivery wagons of 1,000 and 1,100 pounds load respectively; two light gasoline delivery wagons for loads of 500 pounds; one for 700, and one for 1,100. When the various data of the test have been compiled, they will doubtless show some interesting figures as to the improved service given by the autos, and the cost of operating the same.

The Japanese government is being pressed by the industrial and commercial community of Japan as to the necessity for extending the internal railways, but the money originally set apart for the purpose not being now available, the government proposes to invite foreign capital for the necessary works.

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A PORTABLE OXYGEN-INHALING APPARATUS.

BY EMILE GUARINI.

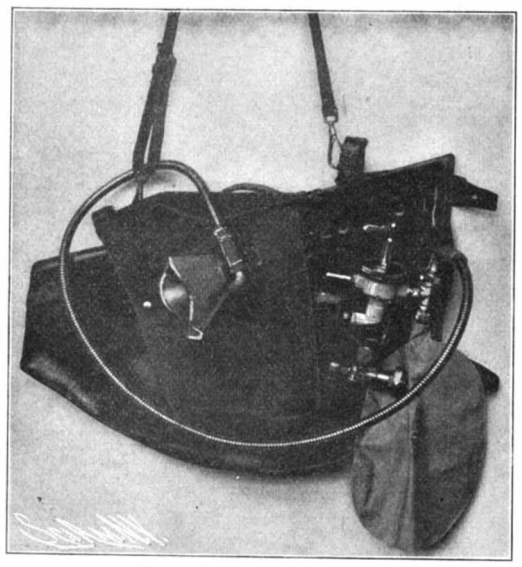
The apparatus illustrated herewith is the invention of Dr. Guillelminetti, and seems to us to be destined to render very great services. In 1891 Dr. Guillelminetti, in the capacity of physician, accompanied the expedition of the astronomer Janssen for the construction of an observatory at the summit of Mont Blanc. He purposed to study the influence of atmospheric depression upon himself and a score of guides and carriers, during a stay of two weeks at an altitude of 14,430 feet. During the first few days, all the members of the expedition were seriously attacked with mountain sickness, and Dr. Jacottet, of Chamounix, died in a hut among the glaciers, a victim of the altitude. Later on, Dr. Guillelminetti observed the same symptoms in a free balloon on the occasion of half a score of physiological ascensions made in November, 1901. In the train of these observations, he undertook some researches upon the efficacy of the inhalation of oxygen in balloon and mountain sickness. Such researches contributed toward the invention of the oxygen inhaler, the construction of which he intrusted to the Draegerwerk establishment of Lübeck. This apparatus permits of inhaling oxygen directly from a compression tube by means of a manometric expander. This latter is so regulated as to allow of the passage of 180 cubic inches of oxygen per minute—a quantity that the inventor deems fully sufficient in all cases in which recourse is had to inhalations of this gas. Formerly, when a physician prescribed inhalations of oxygen, the pharmacist transferred the compressed gas from the cylinder to rubber bags of 1,800 cubic inches capacity and costing from 40 to 60 cents each. The use of oxygen in therapeutics was for that reason too expensive, although a 35-cubic-foot cylinder of the gas stood the manufacturer in but a dollar or a dollar and a half. On the other hand, rubber gives oxygen a disagreeable odor, and, through the friction of the internal walls of the bag, there forms a dust that may be inhaled by the patient and pass into the respiratory tracts. In order to obviate such inconveniences, the experiment was tried of placing an expander directly upon the oxygen cylinder, but this did not permit of ascertaining the quantity of gas that escaped per minute, that is to say, how long a cylinder of oxygen would last—a very important matter in practice, particularly to the aeronaut, to whom it is of importance to know during his ascensions how many hours the supply of oxygen taken along will hold out. Dr. Guillelminetti's apparatus presents another advantage. Formerly the current of oxygen was always continuous, either when the gas was inhaled from rubber bags or by means of an expander fixed to the cylinder. Hence it necessarily followed that the oxygen that flowed during the exhalation escapes as a pure loss. In order to remedy such an inconvenience, Dr. Guillelminetti has interposed in his apparatus a Draeger reservoir consisting of a bag of thin goldbeater's skin, into which the gas flows during the patient's expiration.

The mask of the apparatus is of metal, and is consequently easily sterilized. Its proper operation is assured by an expiration valve of very light glass. It is, in addition, provided with an air inlet consisting of a small free aperture, in order that the oxygen shall not be inhaled in a perfectly pure state.

In order to make use of the apparatus, it is necessary, as soon as the expander is secured to the oxygen cylinder, to open the cock that controls the latter. There is then nothing more to be done, as long as the gage shows that gas remains in the cylinder, but to move the lever that controls the flow of oxygen.

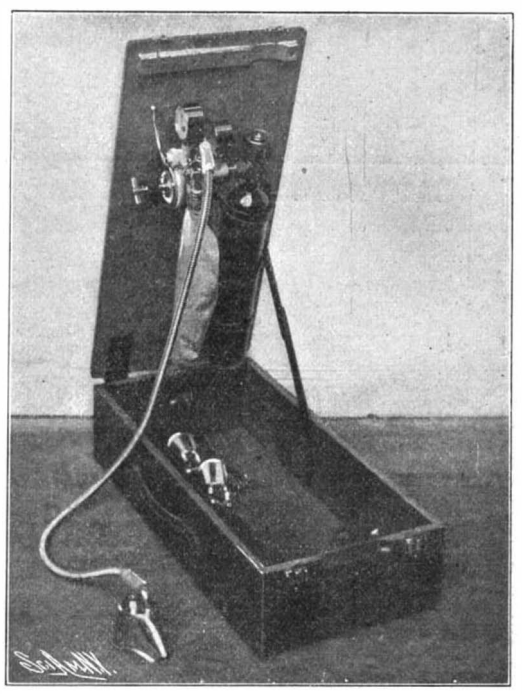
As for the masks, there is one for the mouth and nose simultaneously, and one for the nose alone and one for the mouth alone. They have the form of a small pipette, very simple and very practical. The mask for the face may be easily put on by means of an elastic band passing around the patient's head in such a way as to leave the hands entirely free.

Dr. Guillelminetti has also devised a life-saving apparatus, which is merely the oxygen-inhaling one practically fixed in a small portable box or in a bag that may be attached to a bicycle. This is especially designed to be used in cases of asphyxia, in which it is of importance to administer oxygen at once, and in which a few minutes may decide the life or death of the patient. On the other hand, everything must be immediately ready to operate. The oxygen cylinder contains but 4.25 cubic feet, which suffices for an inhalation of 40 minutes at the rate of 180 cubic inches per minute. The mask is fastened on the face as has already been described, and this permits of proceeding at once to artificial respiratory motions.

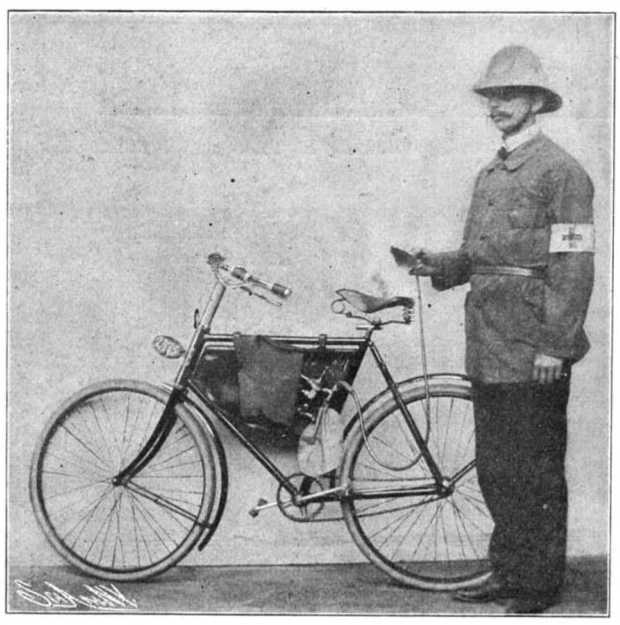


Portable Apparatus Carried in a Bag.

Guillelminetti's Oxygen-Inhaling Apparatus.



Portable Apparatus Carried in a Box.



Portable Apparatus Carried by a Bicycle.

A PORTABLE OXYGEN-INHALING APPARATUS.

A Wonderful Clipper.

The achievements of the five-masted steel bark "Preussen," 5,081 tons, built in 1902 for the Laeisz shipping agency of Hamburg, the largest square-rigged bark in the world, have excited much interest of late. The most remarkable performance of the "Preussen" thus far has been the completion of the voyage from the Channel to Iquique, Chile, a distance of 12,000 miles, in 57 days—about the time made by the steam freighters engaged in the South American trade. On this voyage the vessel took her departure from Quessant March 5, 1903, and crossed the line March 18, thirteen days out, establishing a record never before equaled by a sailing ship. The parallel of 50 deg. S. in the Atlantic was attained April 10, and in the Pacific April 21, eleven days being thus spent in weathering that most tempestuous of regions, Cape Horn. From noon of April 23 to noon of April 24 the vessel laid down 368 miles to her credit, this being the best day's run throughout the voyage. The anchor was dropped in the harbor of Iquique May 1, which made fifty-seven days from point of departure to destination.

It is expected that the Agra-Delhi chord line of the Indian Midland Railway will be opened toward the end of 1904.

The Uses of Natural Gas.

The most profitable customers that the natural gas companies have are the householders. Natural gas is eminently fitted for domestic uses, as every woman who has cooked by its convenient flame has realized, if she has ever had occasion to abandon it for a wood or coal range. She does not wonder that the gods were jealous of the hero who brought fire down from heaven in a hollow reed and showed men how to warm and light their homes and how to cook their food. His was a god-like gift and meant to mankind the beginning of civilization. It is from such primitive uses of fire as Prometheus taught that the natural gas companies of to-day derive nearly all their revenue. They supplied natural gas to 509,695 domestic consumers in 1902, and blessed not less than 4,500,000 people with it as an illuminant.

So says Mr. F. H. Oliphant in his report on the Production of Natural Gas in 1902, which has just been published by the United States Geological Survey as part of its annual volume on Mineral Resources. He says many other pertinent things in this report. Natural gas, he states, is used on many other hearths than the purely domestic. Iron mills, steel works, glass works, and various other establishments to the total number of 8,103 made use of its energies in 1902. The number of natural gas companies that supplied the 509,695 home-consumers and the 8,103 establishments in 1902 was 2,147, which represented a gain of 602 companies over the enrollment of 1901.

One of the most effective uses to which natural gas has been put is as motive power for engines. The natural-gas engine came into favor about ten years ago, when its use was first employed in pumping wells. Afterward, in forms of magnitude ranging from 5 to 500 horse-power, it was extensively introduced into manufacturing plants, where it has successfully demonstrated its economy and reliability. It has in many cases replaced the steam engine and boiler. Owing to the large number of points that are often widely separated and are difficult to supply with other fuel, it is particularly applicable to the pumping of oil wells and to driving pipe-line pumps.

In connection with a mantle of alkaline earth, natural gas has produced the cheapest and best illuminant known. All natural gas has not, however, the same illuminating value. In some districts it carries a small percentage of the heavier hydrocarbons, which add much to its illuminating properties.

Only one article is manufactured from natural gas. That is lampblack, for which a considerable quantity of the annual production of natural gas is employed.

M. U. Schoop, in a recent number of the Elektrotechnische Zeitschrift, records the results of a comparative study of the familiar lead accumulator and Edison's alkali accumulator. The parallel between the lead and alkali accumulators, though not complete, goes to show that nickel sheets or steel sheets plated with nickel in alkali solution, when exposed to the effect of currents, will not be altered in the least, even after weeks, corrosive effects being, as is not the case with the lead peroxide plate, never observed. The author, however, thinks it possible that the active masses present in perforated pockets in the form of compressed powders devoid, it appears, of the adhesive properties of lead salts, would drop from their supports in course of time. As regards the life of lead accumulators, even in the best of accumulators the positive lead support is gradually destroyed by oxidation, the negative mass diminishing progressively in capacity; the need of durability is, therefore, absolutely in disaccord with the demand for a small weight.

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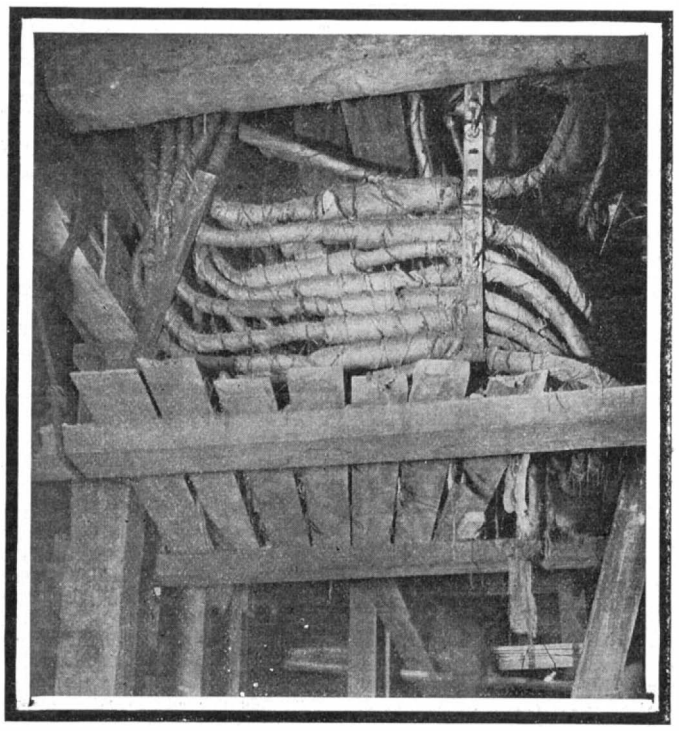
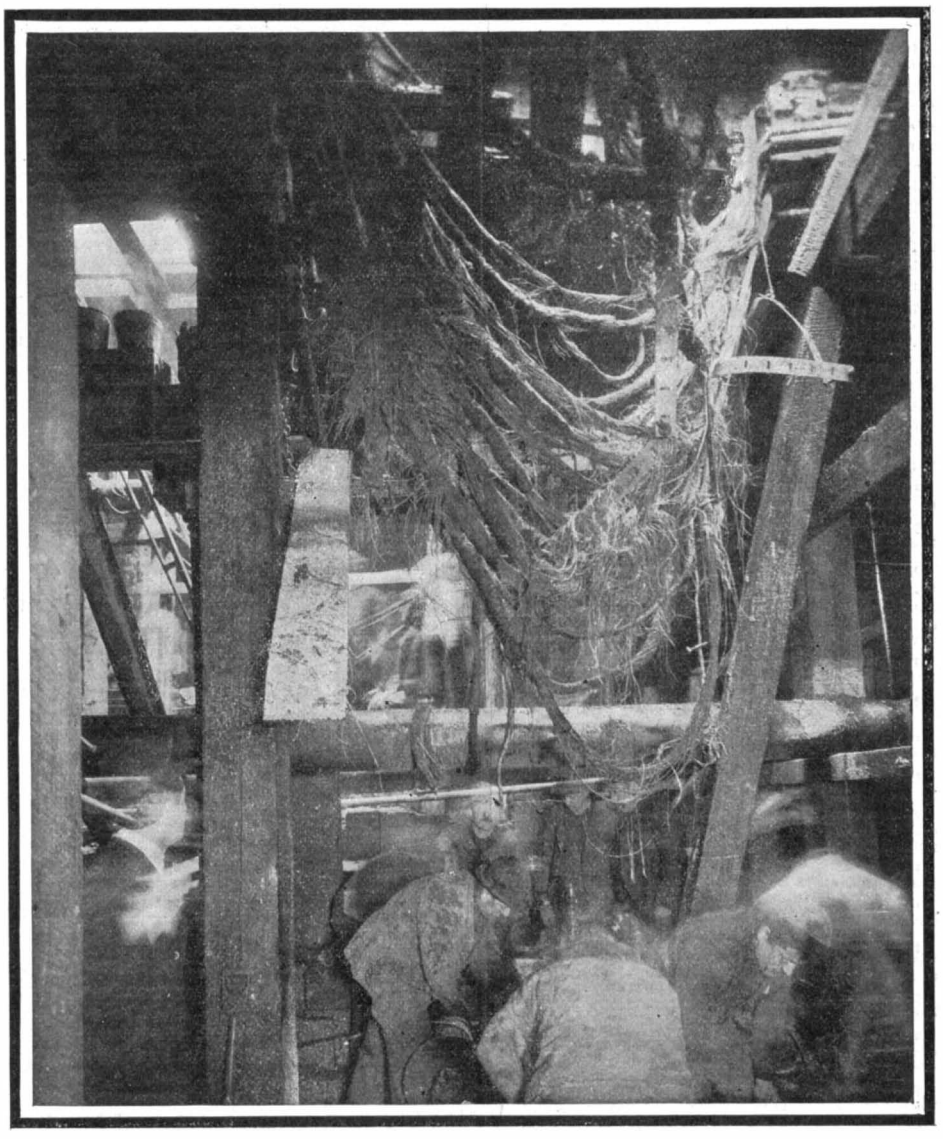
A PECULIAR BLAZE IN THE NEW YORK SUBWAY.

The blaze in the subway at Fulton Street last week offers a typical example of one of the many freakish fires which the New York fire department is every now and then called upon to handle, and incidentally shows the wonderful recuperative powers of the telephone and telegraph companies of New York city. The subway at the point where the fire occurred is being excavated by what is known as the "covered excavation" process, that is, the street paving is replaced by heavy planks which are supported on columns, and excavation is carried on underneath this planking. The iron pipes which cover the telephone and telegraph wires are carried along the top of this tunnel ceiling. The wires, it will be understood, are wrapped into cables and covered with a soft lead sheathing. A brick and concrete manhole which was formerly located at Fulton Street had to be torn away to permit building of the subway, and the cables which at this point were not protected by iron pipes, were supported on a wooden platform hung from the beams of the ceiling, and were for some mysterious reason wrapped with burlap. The fire was caused by some telephone repair men who, while driving out the moisture from some of the wires by pouring heated paraffin over them, incidentally set fire to the paraffin. A dense smoke was emitted by the fire which drove the men out of the subway. The blaze quickly communicated to the burlap covering, and developed sufficient heat to melt the lead sheathing of the cables and attack the insulation of the wires within. The fire was quickly extinguished by the firemen who arrived promptly on the scene; but the havoc wrought in the mean time was tremendous. The accompanying photograph of the scene shows what a hopeless tangle the telegraph and telephone companies had to unravel. Over 5,000 telephone wires, 1,400 telegraph wires, a large number of private wires, and some of the fire-alarm wires were broken, bent, twisted, snarled, and fused together in a seemingly inextricable mass. Thousands of circuits were broken or short-circuited. The New York Telephone Company suffered the worst damage. At the Cortlandt Street exchange, every signal on the switchboard flashed forth at once, creating the wildest confusion. The station was obliged to suspend business, thus seriously inconveniencing a large part of the lower New York business and financial district.

Repairs were begun immediately and thirty-four hours after the fire the tangle had been all cleared and the circuits restored to their normal condition—a most wonderful achievement when the difficulties of the situation are considered. The iron tubing had to be cut away at each side of the damaged section in order to expose uninjured lengths of the cable on which the repairmen could operate. Each wire of the cable had to be sorted out and its number ascertained from the central exchange before the wires could be spliced together. This was done in the following manner: A wire of a certain number was grounded at the central. At the break a telegraph relay and battery were provided. One of the relay terminals was grounded and by connecting different wires to the other terminal one was finally reached which completed the circuit through the relay, as indicated by a "click" of the sounder. That wire was then secured in an index board in a slot labeled with the number of the wire, as telephoned from the central station. This operation was greatly expedited by connecting a large number of wires at a time with the relay and then, if a click was heard indicating that the sought-for wire was to be found in that bunch of wires, they would be separated into two groups. The group that next produced a click would then be further divided, until it was narrowed down to the desired wire. Owing to the large number of cables which had thus to be operated on, and the limited amount of space available for the repairmen, it was decided to splice together the wires of certain of the cables without attempting to sort them out and then breaking the cables in the vaults at the central to sort out and connect the proper wires with each other. This, of course, necessitated more splicing of wires, but it resulted in a considerable saving of time, owing to the fact that the cables could all be operated upon simultaneously. It is estimated that 25,000 splicings were made. The repairs were necessarily temporary, because in their haste to bring the system back to its normal state the telephone company made connections without running the cables through the iron tubing. It will now be necessary to connect the temporary wires with permanent wires run through iron tubes, which, however, can be done quite easily without in any way interfering with the operation of the telephone system.



POSITION OF THE TELEPHONE CABLES BEFORE THE FIRE OCCURRED.



DISASTROUS RESULTS OF A SMALL BLAZE IN THE SUBWAY.

Homogenized Milk.

BY E. W. ALLEN.

To the many methods of purifying, modifying, and preserving milk must now be added a process for *homogenizing* it so that it will keep almost indefinitely without change in its physical condition. The tendency of the fat globules to separate from a condition of suspension or emulsion, as they occur in freshly drawn milk, and to collect at the surface in a layer of cream, causes milk to lose its homogeneity very quickly; and while this creaming tendency is highly advantageous in butter making, it is objectionable for many purposes to which milk is put. The fat globules in milk vary greatly in size. Not only are those of some breeds and individuals of a large average size, but in the same sample of milk there are always a considerable number of very minute globules and others that by comparison are quite large. The larger globules rise to the surface more rapidly, and have a greater tendency to coalesce. The very smallest globules never rise, but remain in a state of suspension.

This inactivity of the smaller globules has suggested a mechanical means of rendering milk non-creaming and thus preserving its homogeneity. Such a process has been perfected and patented by Gaulin of Paris, and is coming into use in Europe. It is designed to reduce all the fat globules to a very minute size, by means of pressure and concussion. Milk heated to about 185 deg. F. is placed in a closed drum, and under a pressure of 250 atmospheres is forced through a series of very fine openings, the jets as they issue coming in contact with a porcelain plate which is held in place by a stiff spring. The effect is similar to that produced when mercury is poured on the floor. The fat globules are broken up by the concussion into very minute particles, which do not tend to coalesce or rise to the surface. Under the microscope the globules appear as almost immeasurably fine granules, distributed uniformly through the milk, and are evidently more intimately associated with the casein. While the globules in ordinary milk range, on an average, from 0.0016 to 0.01 millimeter in diameter, those of the treated milk average only about 0.0008 millimeter in size. Samples of the treated milk have been kept for six months without change in the character or uniform distribution of the fat globules. Furthermore, treatment of the milk in a powerful centrifugal machine which creamed ordinary milk completely, had practically no effect on the "fixed" milk, showing how thorough had been the change in the mechanical condition of the fat.

An investigation was recently reported in the British Medical Journal of the process as carried out by a dairy company in London. In this case the "fixing" was combined with pasteurization, and the milk was aerated with a mixture of oxygen and carbonic acid under pressure as it was bottled. The only apparent change in the milk was in the fat globules, the other constituents, including the proteids, being found to be unchanged, and there was no decrease in digestibility as shown by experiments in artificial digestion. The treated milk kept perfectly sweet for over six weeks, and remained sweet for several days after opening. It showed no tendency to cream, but was perfectly homogeneous when the bottles were opened.

The process is thought to be especially applicable in putting up milk to be kept a long time, or partly condensed milk to which no sugar has been added. The cream which rises in a buttery mass in the neck of bottles of pasteurized milk is difficult to diffuse uniformly through the milk when it is used, and this has been an objection to ordinary pasteurized milk, especially for children's feeding.

The apparatus in most common use treats about 2,000 pounds of milk an hour, and requires 7 horse-power for its operation. It is said to be easily cleaned, and the parts coming in contact with the milk are mostly of bronze. To prevent clogging the machine, the milk is filtered before entering the drum, which takes out all the fine particles of dirt.

Crypt Under St. Mark's.

Signor Manfredi, an architect attached to St. Mark's of Venice, while engaged in reproducing the floor of the basilica, found the remains of ancient constructions, among them parts of a crypt and a tomb, with a Byzantine cross of the seventh century. The discovery is considered of much historic importance, and is being widely discussed by archæologists.—New York Tribune.

A complete mint, in operation, is one of the features shown by the United States government at the World's Fair. At the close of the Exposition the plant will be sent to Denver, Colo., for permanent use.

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RECENTLY PATENTED INVENTIONS.

Electrical Devices.

ELECTRIC-LIGHT-CIRCUIT PROTECTOR.—S. KALBACH, Wildwood, N. J. The invention relates to means for preventing interruption in the current fed to electric lamps caused by the disorder of one of the lamps. It frequently happens where electric lamps, and more particularly arc-lamps, are operated together in series that if the circuit of one lamp be left open, it will have the effect of stopping action of other lamps. It has been found that most of the annoyance caused by street electric lamps is due to electric-light leads. Much trouble of this kind is obviated by this device.

Of Interest to Farmers.

WINDROWER.—H. M., L. A. and J. A. MUELLER, White Lake, S. D. In this case the object is to provide a windrower or bunching attachment for mowing-machines, arranged to gather hay, millet, short wheat, and the like as fast as mowed by the machine, and to enable the operator to easily and quickly dump the gathered material in windrows without scattering or losing any of the material between adjacent windrows.

FENCE-POST.—C. H. LEWIS and C. BOOK, Harpster, Ohio. The construction of this post comprises a main upright with a brace extending downward therefrom. An arched bar is connected to the upright and brace, and the lower ends of the bar members are sunk in anchoring-disks. The upright and brace each has an outwardly opening slot at its lower end, the arched bar having its upper portion secured in the slots. It will be impossible to draw the post out or to move it out of its vertical line.

GRAIN-DRILL.—R. D. BROWNING, Orange, Va. The object in this instance is to provide means for regulating the depth that the disks of disk-drills shall run in the ground, and is specially adapted to hilly or rolling land. The disks are divided into sets, preferably a set on each side of the center of the drill and have means for regulating each set independently of the other and for locking the sets in any adjustment with reference to each other.

Of General Interest.

SPRING BED-BOTTOM.—S. H. ANDERSON, Vandergrift, Pa. In this case the invention relates to spring bed-bottoms, the more particular object of the inventor being to produce a neat form of such a device made so as to fold. The bottom is made in two halves for convenience in folding. When the bed-bottom is to be folded, certain means enable the bottom to be doubled upon itself, and leaving the base ends of the springs extending outward The wires that engage the springs are woven together into a fabric having large square meshes, the length of each mesh extending from center to center of each spring.

SAFETY-LOCK FOR GAS FIXTURES.—E. H. SHUTE, Chicago, Ill. The object of the invention is to provide a locking device for the valve or cock of a gas-fixture which will automatically lock the plug or key of the cock in closed condition when the key has been turned to shut off the flow of gas from the gas-burner that is a part of the fixture.

REFRIGERATOR.—J. M. DOPPEL, New York, N. Y. This refrigerator is so constructed that while it is packed with a non-heat-conducting material a perfect circulation of air will be obtained around both sides of the packed section, to which end air-ventilating spaces or chambers are located between the packed section and the inner box or receiving section and the said packed section and the outer box or casing section, which air spaces have connection with the outside atmosphere. The invention relates to the construction of refrigerators in which receptacles containing ice-cream are to be stored or from which the cream is served.

FOLDING BOX.—M. HIRSCH, New York, N. Y. In this patent, the invention refers to improvements in foldable boxes; and one of the objects in view is the provision of a one-piece blank adapted to be cut or stamped from suitable paper-stock without waste of materials, the blank being bendable into the shape of a complete box without pasting or gluing any of its parts.

CUSHION FOR DOUCHE-PANS.—HARRIET E. FELTHOUSEN, Jersey City, N. J. One object in view in this case is to provide a padded cushion which promotes the comfort of a sick person during the service of the pan by affording a soft pad whereon the body may rest without coming in contact with the hard material or sharp edges of the pan, thus dispensing with towels and other padding. The pan parts may be cleansed and dried rapidly.

SUSPENSORY BANDAGE.—E. R. DRAKE, De Land, Fla. Mr. Drake's invention is an improvement in that class of bandages in which an elastic leg-band is employed, the leg-band being connected with the scrotal bag and also with the body band. Means are provided by which the band may be turned if worn and frayed by friction with the ring on the edge of the scrotal-bag, and to render the leg band elastic when the strain is greatest and change of strain almost constant.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**

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Marine Iron Works. Chicago. Catalogue free.

Inquiry No. 5381.—For parties engaged in manufacturing small wooden novelties, to order, also for firms who stamp small articles out of sheet brass.

AUTOS.—Duryea Power Co., Reading, Pa.

Inquiry No. 5382.—For manufacturers of hydraulic rams.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 5383.—For manufacturers of old-style cut-offs for slide valve engine on steamboat.

For bridge erecting engines. J. S. Mundy, Newark, N.J.

Inquiry No. 5384.—For makers of street railroad cars propelled with gasoline.

Handle & Spoke Mchy. Ober Mfg. Co., 10 Bell St., Chagrin Falls, O.

Inquiry No. 5385.—For makers of aluminium castings and goods.

Sawmill machinery and outfits manufactured by the Lane Mfg. Co., Box 13, Montpelier, Vt.

Inquiry No. 5386.—For manufacturers of compressed paper goods.

American inventions negotiated in Europe. Wenzel & Hamburger, Equitable Building, Berlin, Germany.

Inquiry No. 5387.—For manufacturers of spring fan motors.

WANTED.—Manufacturer to make a patent hollow-tooth hair-drying comb of aluminium or other light metal. A. F. Mott, 65 Clarkson St., Flatbush, L. I.

Inquiry No. 5388.—For makers of small armature punchings, slotted type, for dynamos and motors.

☞ Send for new and complete catalogue of Scientific and other Books for sale by Munn & Co., 361 Broadway New York. Free on application

Inquiry No. 5389.—For makers of elastic webbing such as used in suspenders.

Fine machine work of all kinds. Electrical instruments a specialty. Models built to order. Page Machine Co., 812 Greenwich Street, New York.

Inquiry No. 5390.—For dealers in rubber stamp-making outfits.

Inquiry No. 5391.—For parties who can furnish odds and ends in brass, sheet, strip and wire.

The largest manufacturer in the world of merry-go-rounds, shooting galleries and hand organs. For prices and terms write to C. W. Parker, Abilene, Kan.

Inquiry No. 5392.—For manufacturers of rubber suction hooks used to hang cards, jewelry, etc. on show cases, panes of glass, etc.

The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Refrigerating Machine Company. Foot of East 138th Street, New York.

Inquiry No. 5393.—For manufacturers of a machine that will clean cotton of sticks and straws.

In buying or selling patents money may be saved and time gained by writing Chas. A. Scott, 340 Cutler Building, Rochester, New York.
Highest references.

Inquiry No. 5394.—For parties to manufacture clocks of special construction.

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, machinery and tools. Quadriga Manufacturing Company, 18 South Canal Street, Chicago.

Inquiry No. 5395.—For manufacturers of pails, tubs and kegs which will hold a penetrating grease.

Wanted by a manufacturer owning his own plant with both wood and metal-working machinery, as a side line, some article or novelty that will have a ready sale during fall and winter months, located near Boston, Mass. Novelty, Box 773, New York.

Inquiry No. 5396.—For a firm who manufactures snap buttons and other novelties.

"The Household Sewing Machine Co., Providence, R. I., is prepared to take on contracts for the manufacture of high grade mechanical apparatus, requiring accurate workmanship, in either machine shop, cabinet work, or foundry lines. Expert mechanics, designers and tool makers. Facilities unexcelled. Estimates furnished on application."

Inquiry No. 5397.—For manufacturers of calcium carbide.

Inquiry No. 5398.—For a machine to pick sponges in small pieces without cutting them.

Inquiry No. 5399.—For manufacturers of cheap toys and games.

Inquiry No. 5400.—For makers of castings for gasoline engines ¼ to 1 h. p., suitable for amateurs' use.

Inquiry No. 5401.—For a heavy spring motor with governor to run a light machine.

Inquiry No. 5402.—For makers of machinery to make stove pipe.

Inquiry No. 5403.—For machines for preparing cotton for surgical dressing.

Inquiry No. 5404.—For machines for making pens and pen holders.

Inquiry No. 5405.—For information regarding cost, etc., of small ice-making machinery, capacity of plant 500 pounds in 5 hours' run.

Inquiry No. 5406.—For parties engaged in the manufacture and installation of electric light plants.

Inquiry No. 5407.—For quotations on water motors.

Inquiry No. 5408.—For makers of steel tanks to hold 25 cubic feet to stand 600 pounds' test and high pressure pumps to pump 300 pounds.

Inquiry No. 5409.—For manufacturers of elevators.

Inquiry No. 5410.—Wanted, smooth, bright tin plate for plating purposes, in lots of one to twenty cases at the time direct from an independent mill.

Inquiry No. 5411.—For machinery for separating the outer hulls from the bean of the castor oil plant.

Inquiry No. 5412.—For manufacturers of smoke consumers.

Inquiry No. 5413.—For manufacturers of buckram wire used in manufacturing hat frames.

Inquiry No. 5414.—For makers of gasoline or hot air engines of about ½ h. p.

Inquiry No. 5415.—For makers of small steam engine cylinders of the slide valve type of about 1⅜ inches stroke and ¾-inch bore, either metal or brass.

Inquiry No. 5416.—For a machine for printing on lead pencils.

Inquiry No. 5417.—For a Taylor calculating machine,

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.

References to former articles or answers should give date of paper and page or number of question.

Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.

Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.

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Books referred to promptly supplied on receipt of price.

Minerals sent for examination should be distinctly marked or labeled.

(9364) C. M. M. asks: 1. Will an explosion of gasoline in a cylinder 2.4 inches long by 3 inches bore, standing vertically, lift or throw a piston weighted to 250 pounds 6 feet high? A. The total explosive force in a cylinder as stated depends upon the volume of explosive mixture contained in the cylinder beneath the piston and its compression, as well also upon the proportion of the gasoline vapor and air mixture. The instantaneous explosive effect of a good non-compressed gasoline gas is about 100 pounds per square inch, while the weight of the piston stated is but 35 pounds per square inch, leaving about 65 pounds per square inch, or a total accelerating force of 455 pounds, which, with a volume of 3 or 4 inches in depth in the cylinder, should project the piston vertically from 6 to 10 feet, according to frictional resistance. 2. What size or dimension of cylinder would be necessary to do this? A. The energy effect will be in proportion to the size of the cylinder and the weight of the piston. 3. How many such lifts could be obtained with a quart of gasoline? A. A quart of gasoline should give several hundred impulses as given above. 4. Could the power of a gasoline explosion be thus utilized in a long cylinder, say proportioned as the barrel of a gun? A. We advise that successive impulses in a long cylinder, as in a gun, will not be practicable.

(9365) F. S. writes: It seems to be the common impression in this vicinity, and among people that ought to be informed in the matter, that the older an incandescent electric light becomes, or rather the longer it is used, the more current will it consume, the voltage remaining the same. I do not believe that this is the case, because the few experiments I have made to determine this increase, though crude, gave contrary result. I understand, of course, that the energy consumed per candle power given out increases, due no doubt, to blackening of the globe. This very blackening suggests to me a possible decrease in the sectional area of the filament and consequently increase in resistance and decrease in current passed. A few words of explanation in respect to the above will be much appreciated. A. An incandescent lamp runs down with age, that is, its candle power decreases for same current and current increases for same candle power. The causes are: (1) The wearing away of the filament either by evaporation or by the projection of particles upon the glass, thus blackening the bulb; (2) the blackening of the bulb reduces its transparency, thus preventing some of the light actually produced from being utilized; (3) the capacity of the filament to radiate heat is increased so that more current is required to maintain its temperature and luminosity. It is true that such a lamp will consume more current for full candle power if it can get it, but it is also true that it cannot get more, but will take less current, and gives less light as it grows old, since its filament rises in resistance with diminution of size, and more resistance means less and not more current flowing. If higher voltage is put on the line, the lamp can then take more current. Decrease in light-giving power means also an increase in energy consumed per candle actually realized. Candle power, efficiency and life of lamps are fully discussed in Crocker's "Electric Lighting," Vol. II., which we can furnish for $3.

(9366) C. W. Stuart & Co. ask: Will you please tell us what two metals would best be used in combination to make a thermostat? That is, we want the metal that expands the most with heat and one that contracts (if there is such a one). A. Of the metals adapted for use in a thermostat, zinc has the largest expansion and platinum has the smallest. If platinum is prohibited by its high price, steel, soft annealed, is the next best. There is no metal which contracts with heating, so far as we know.

(9367) R. S. asks: Is there any air in an electric light globe, and how much, if any? Why do they not make it a perfect vacuum? Is black a color? A. There is always some air or other gas in an incandescent lamp globe. It is not a constant quantity, of course, and is so little that it has no oxidizing action on the filament. A perfect vacuum is not made because a perfect vacuum is not a possibility. There has never been one made by a pump. We cannot decide the puzzle whether black is a color or not. Artists do not recognize black and white as colors. Scientists to a certain extent call black a color, in the sense that black produces a different sensation from absence of anything to look at. You will find the question argued in books on physiological optics, and on psychology.

(9368) H. F. G. says: A gas company sells natural gas for purposes of heat at 30 cents per thousand cubic feet at a pressure of 4 ounces. If for various causes the same is furnished at a pressure of 1 ounce instead of 4 ounces, what is the gain or loss in heat units to the consumer? How much is the low-pressure gas worth per thousand cubic feet comparing it with the high-pressure gas at the price named? A. At the pressure of 4 ounces per square inch the volume is as 98.4 to 100 free gas and at one ounce is 99.6 to 100 free gas. The difference is 1.2 cubic feet per 100 or 12 cubic feet per 1,000. If the gas is equal to 800 heat units per cubic foot, your loss will be 9,600 heat units per 1,000 cubic feet consumed. Its value at the low pressure, comparatively, should be 29.64 cents per thousand cubic feet.

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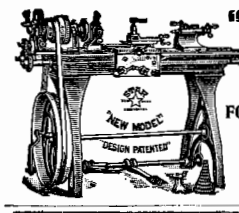
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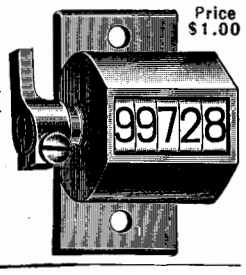

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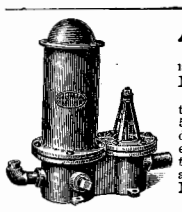
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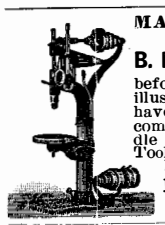
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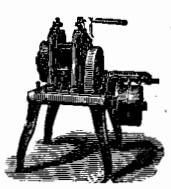

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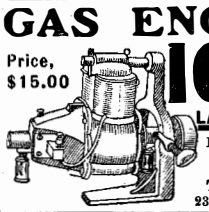
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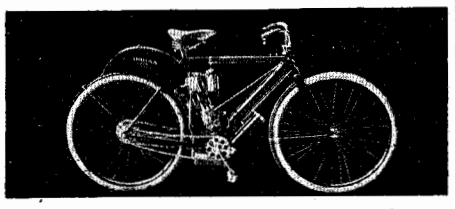

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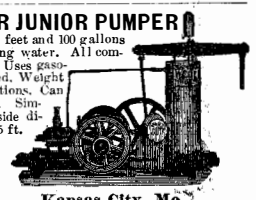

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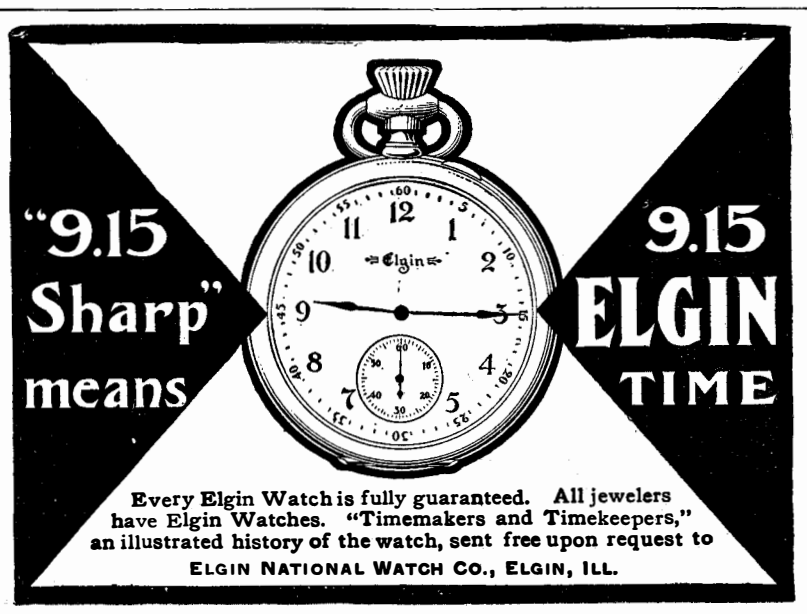
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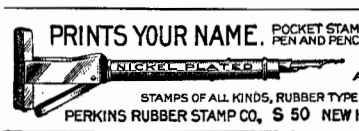

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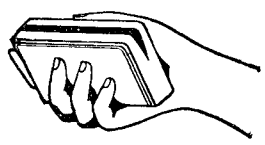

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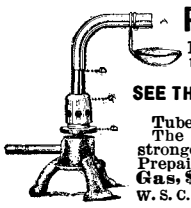

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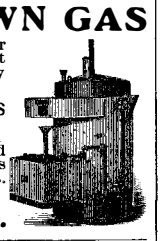

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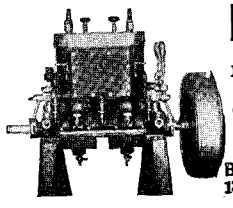

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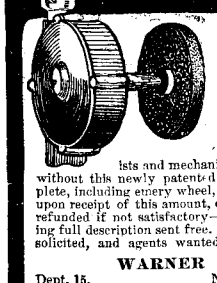

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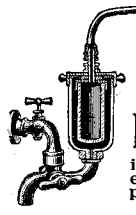

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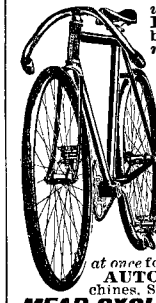

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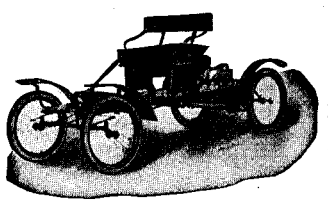

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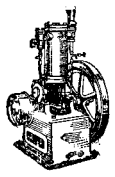

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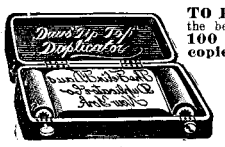

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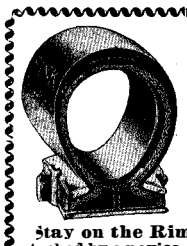

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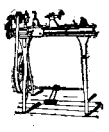

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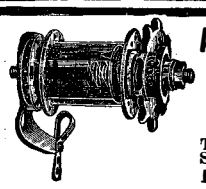

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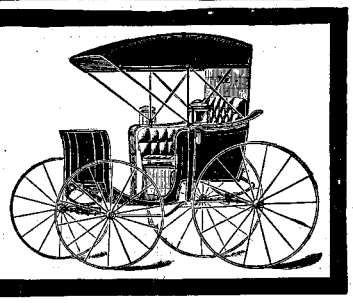

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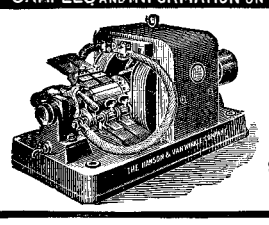

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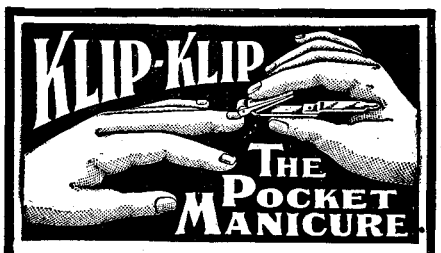

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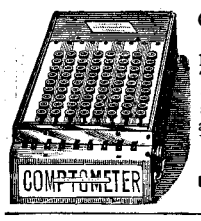

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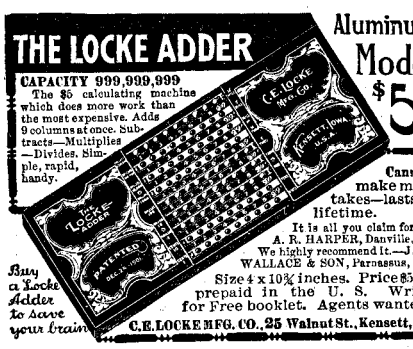

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